RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

With Which is Incorporated
ROADMASTER AND FOREMAN

BRIDGES--BUILDINGS--CONTRACTING--SIGNALING--TRACK

Published by BRUCE V. CRANDALL

Office of Publication: Lytton Bldg., Chicago
Telephone Harrison 6339

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A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, signaling, bridges and buildings.
Communications on any topic suitable to our columns are solicited.
Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 15 cents. Advertising rates given on application to the office, by mail or in person.
In remitting, make all checks payable to Bruce V. Crandall.
Papers should reach subscribers by the twentieth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be gladly sent.

Entered as Second-Class matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

New Series, Vol. XI
Old Series, Vol. XXX
Chicago, July, 1915
No. 7

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Live Loads for Structures

A number of years have elapsed since the universal adoption of heavier live loads for railroad bridges and other structures. As a consequence, modern types of structures have not only undergone radical changes, but old structures have had to be strengthened or altered to fit present traffic conditions.

The maintenance of structures has undoubtedly revealed advantages and points of weakness in old and approved as well as in new types, and a full knowledge of the practical experience in maintenance would be very desirable to the designers of railroad structures.

We solicit contributions from our readers descriptive of maintenance work on railroad buildings of all kinds—structural steel, plain or reinforced concrete. Such contributions, if acceptable, will be purchased by us at our usual space rates. Address Editor *Railway Engineering*, Lytton Bldg., Chicago.

Water Pockets and Ditches

Soft foundation results in serious defects in track. Soft spots may be caused either by underground or surface water, but it is probable that most of the trouble is caused by rain penetrating through the ballast and not finding an outlet through the shoulders of the sub-grade.

Much of this trouble can be traced to careless work during construction, although some of it is due to wrong methods used in the placing of the material.

Two suggestions for bettering sub-grades have recently been made which merit attention; one of these is to use a steam roller to compact the earth in layers as it is placed, and the other is to wet or flood the embankment down as it is being built. The latter method was used by one railway in some track elevation work in Chicago, and it does not seem that it would be adaptable to an ordinary embankment without a retaining wall. It is much easier in track elevation work to wet down the earth as it is placed than in new construction, for in track elevation work it is not necessary to immediately use or complete the grade in any certain spot. It is possible to unload a quantity of filling, wet it down and then leave the fill to settle and dry out while the unloading gangs are transferred to some other point.

Immense quantities of ballast have been needlessly used in trying to fill water pockets or to maintain track on a wet sub-grade. This is not only a waste of valuable material and labor, but makes the situation worse. Whenever soft spots develop in the road bed, an investigation should be made, and it should be extensive enough to indicate the exact condition of affairs and what remedy will actually eliminate the trouble. Half way or patching up measures will not suffice. If it is not possible to make a complete,

permanent job and spend sufficient money to absolutely cure the condition, the money which is spent will probably be entirely wasted.

The remedy for water pockets in embankments is usually some sort of a cross drain. In cuts the ordinary track ditch, tile, French drains or something of the sort, will usually be found to be sufficient, although it is sometimes necessary to put in cross drains also to reach into the water pockets under the track.

Not enough attention has been given to the subject of proper design, construction and maintenance of track ditches. The data obtainable on this subject are very meager. Some investigation of silting and scouring has been made in irrigation canals. Silting or filling up of ditches is decreased by making the cross section and gradient uniform, and by constructing and maintaining the ditch so that there will nowhere be a decrease in the velocity of the current. These are more or less theoretical considerations, as it is usually the earth washing down from the slope of the cut which fills up the ditch and necessitates cleaning, or it may be weeds which have choked up the ditch.

It does pay, however, to dig ditches with straight sides, and the bottom on a uniform grade. Any sags which occur in the bottom of the ditch are likely to hold water, particularly in earth cuts in wet climate, and this water will promote the growth of weeds in the low spots. Of course, a ditch which was originally dug carefully with bottom a uniform distance below the track is easier to clean out and keep in first-class condition.

One thing that should be guarded against is decreasing the cross section of the ditch near the mouth, as this not only tends to choke it up when the ditch is full of running water, but causes the ditch to rapidly fill up with dirt at that point.

Investigations in connection with irrigation work have shown that with a smooth bottom and smooth sided ditch there will be no scouring, no matter how high the velocity of the water. In other words, if the sides and bottom of the ditch are smooth and uniform, there will be no tendency for the water to scour out dirt from one side of the ditch and deposit it at some other point.

Practically all track men concede that the correct drainage of track is one of the first requirements in correct maintenance, and as the ordinary open ditch forms the great part of the drainage system in the cuts on a railway, we request articles on this subject, both on construction and maintenance, in accordance with the following outline:

(1) What precautions should be taken in construction which will make it easier to maintain adequate ditches?

(2) Do you handle the excavated dirt with flat or dump cars? Which have you found most economical—flat or dump car trains—giving initial cost, operating cost, upkeep cost, yardage moved, etc.

(3) If you use dump cars, what size and capacity do you favor, and do you favor the use of air or hand dump cars?

(4) What is the maximum haul which you have found to be economical, using dump cars?

(5) What methods tend to produce ditches that will remain open? This refers particularly to methods for obtaining a good bottom on the ditch, a good slope, uniform section, etc.

(6) Give in detail instances where proper ditching has improved the roadbed and thereby reduced maintenance expense.

(7) Give instances of emergency ditching, following slides, etc., giving methods used and results.

(8) Have you used ditching machines?

(9) Describe type used, methods of operation and results accomplished.

(10) If you have had success with ditching machines, send a photograph or photographs with your article, if possible.

It is not necessary to follow this outline closely, it being merely given in order to suggest to the mind of the practical track man some features which we think will bring out valuable discussion.

Contributions on this subject should be addressed to Editor *Railway Engineering,* Lytton Bldg., Chicago.

Concrete Stone

In the early days of the concrete industry "concrete stone" or the concrete block, as it was called, was shunned by architects and engineers, and in most cases rightfully, on account of the very poor quality of the imitation cut stone blocks put on the market. When the concrete industry grew and expanded the block industry did not grow apace because of the reputation it had gained through the efforts of those who sought to get rich quick.

The conditions at the present time have changed greatly, and we find concrete stone being manufactured in the proper way and the industry growing rapidly because a comparatively few men have demonstrated conclusively that concrete stone with a great variety of facings can be made at a greatly reduced cost which is almost the equal of the particular kind of natural stone it imitates.

Concrete stone trim can be cast in any desired shape and facing, and by using a wet mixture of concrete for the base and reinforcement in large pieces a very strong material is produced. Several railroad companies have noted the economy of concrete stone as a substitute for stone and terra cotta trim on stations, shops and office buildings, and are now making use of the new material.

A number of the stations of the Buffalo, Rochester & Pittsburgh Ry. stations (to be described in a future issue) have Litholite trim, a trade name for concrete

stone used in place of cut stone, the desired effect being obtained at a greatly reduced cost. In the construction of the Delaware & Hudson R. R. office building at Albany, N. Y., recently completed, $55,000.00 worth of concrete stone was used at about two-thirds the cost of limestone trim. According to the architect's statement this concrete stone has kept remarkably free from discoloration, although exposed to the smoke of nearby railroads, and has given better satisfaction than the limestone trim would have given.

These examples are sufficient to show that concrete stone is especially adapted to and being used with success in railroad structures, and we predict a rapid growth of the industry in this field.

Testing Concrete Aggregates

The practice of requiring cement to be tested to ascertain its fitness for use in concrete is almost universal, but the sand and stone which makes up the greater portion of the finished product are very seldom tested except by casual inspection. Such a condition of affairs is manifestly in error and not in line with the now prevalent ideas of efficiency and economy in the use of materials of construction.

We have known of cases where the men in charge of work have insisted that the cement pass the standard requirements, but lodged no complaint against the use of decayed sandstone strippings which could be pulverized by rubbing two pieces together in the hands. And sand has been used which contained undue amounts of clay and loamy material. Wherein is the logic of demanding that the cement used to form concrete with such aggregates should pass standard tests while the materials making up the greater portion of the final product would not pass the fundamental requirements of cleanness and hardness?

In the past we have been entirely too quick to put the blame for poor concrete on the cement, and there is little doubt that in the great majority of cases it should have been placed on poor aggregates. To have concrete of first quality, all the component parts should be of first quality; and this is difficult to achieve unless one has some standard to follow.

We have standard tests for cement, and it is therefore just as logical to have standard tests for the large and small aggregates. Let us be more precise in our specifications for aggregates by setting forth standard requirements such as certain crushing strengths for small cubes of stone of different kinds, and for small cubes of sand and cement of certain proportions, as a check on the strength of the sand. When this is done and lived up to, we can expect to have better concrete; and what is more, the procedure will be more consistent with the advance in technical knowledge than the crude "hit or miss" methods of testing the aggregates forming the greater part of the mixture.

Beam Connections

From a series of tests of beam connections recently made in the college of civil engineering of Cornell University, the conclusion can be drawn that, for the larger sizes of I-beams, a material reduction in the size of the connection angles, as well as in the number of rivets, can be made without appreciably reducing the strength as compared with the strength of the well known standard connections. The reason for this result is the decrease in the eccentricity of the connection, by arranging the rivets in one line instead of two lines, such as are provided in the outstanding leg of the standard connection angles. The American Bridge Company, which co-operated in these tests, has adopted as standard some of the special connections tested in the series. The substitution of 4x4 in. angles for 6x4 in. angles can be made for practically all cases of larger size I-beams where the old standard connections could be used without special investigation. The old standard connections as well as the new symmetrical special connections must be used with caution for spans so short that the beam web is in danger of buckling.

For 8 in. or smaller I-beams it is inadvisable to decrease the number of rivets because the web is the weak point and the connection must be made as stiff as possible in order to decrease the very high stresses due to eccentricity.

The significance of these tests, which were described in the "Cornell Civil Engineer," is that they demonstrate the great possibilities for economy of research work in the field of structural-steel engineering. Standard end connections have for many years been considered a closed chapter and it did not seem probable that any changes could be devised which would result in marked economy. Structural-steel engineering is, to a too large degree, the application of tables, rules and standard details, a good many of which might perhaps be replaced by more economical details. It is unnecessary to mention the great importance of this subject to railroad engineers.

Structural Engineers' License Law

Railroad structures of almost every description belong to the class of structures for the design of which, in the state of Illinois, engineers will have to be licensed, according to the structural engineers' license law which was recently signed by the governor. Before commenting on its provisions, it will be necessary to study it thoroughly. The attention of all railroad engineers is, however, called to this law, which was mainly intended to break the monopoly enjoyed by the architects in Illinois for the design of buildings. The strong opposition

of the organized architects resulted in several amendments to the original bill, restricting the field of the structural engineer in the building line. Since most railroads handle the design of their structures by their own engineering forces, and since there is not much business in other branches of structural engineering, the engineers in the state of Illinois will have to work for an extension of their field in building work which absorbs the largest percentage of engineers.

Of great interest to railroad engineers is the provision of the law which stipulates that licenses will be issued (within 6 months after the law goes into effect) to engineers engaged in structural engineering, upon application, without an examination, provided certain other requirements are proved to the satisfaction of the board of examiners. After 6 months an examination is required of everyone. Any railroad engineer who contemplates practicing engineering at some future time might, therefore, find it advisable to make application for a license soon after the constitution of a board of examiners.

Burnt Clay

Some recent tests made at the Engineering Experiment station of Iowa State College, using burnt clay refuse from clay products plants as an aggregate for concrete, are interesting, although the tests were not extensive enough to obtain definite conclusions. The burnt clay weighed 71 lbs. as compared with 93 lbs. per cu. ft. for the stone, while the absorption per cubic foot was nearly double that of stone, viz. 5.50 lbs. for burnt clay and 2.83 lbs. for stone. The average compressive strength of 6 in. cubes at 28 days was 1,250 lbs. per sq. in. for burnt clay concrete and 860 for stone concrete, while tests of two similarly reinforced beams made of the same material as the cubes, showed that the stone concrete beam was good for only 73% of the load at which the burnt clay beam failed, the center applied loads being 47,500 lbs. and 65,000 lbs. respectively.

A GRAND PRIZE

The only medal of honor awarded for rail joint products in the transportation department by the Panama-Pacific Exposition at San Francisco was to the Rail Joint Company of New York.

The Alabama Great Southern will at once build a new station at Twentieth street, Bessemer, Ala., to cost $30,000. The building is to be of brick construction with Spanish tile roof and cement floors. The company's forces will carry out much of the construction work.

The New Jersey harbor commission has filed a report with the United States Army engineers condemning the bridge of the Central Railroad of New Jersey over Newark bay, connecting Elizabeth and Bayonne, N. J. To replace the present bridge would cost the railroad, it is said, approximately $2,000,000.

TESTS OF TRACK SCALE

The track scale installed by the Baldwin Locomotive Company at Eddystone, Philadelphia, Pa., was recently tested by the employes of the Pennsylvania R. R. as follows: (1) With one 50,000 lb. test car; (2) with one 80,000 lb. test car; (3) with both of the above cars, one at each end of the platform; (4) with both of the above cars at each end and center; (5) with three cars. A 50,000 lb. car in the center and two 80,000 lb. cars at the ends.

The results of this test are shown on the report of February 12th, 1915, and indicates that with a 50,000 lb. car no errors were visible, but with a heavier car fluctuations appear differing in the second test from 80 lbs. heavy to 10 lbs. light. There was a still further increase in the errors when two test cars were used which distinctly indicates a loss of weight in the third test, which may be due to various causes, possibly to the reversal of test cars by which a slight dislocation of the platform occurred. In the fourth test a confirmation of the second and third test conditions were found, namely: the loss of weight still existed, but was small. In the fifth test the three test cars indicated conditions which upset the theory that the error grows with the increase of loads. A strictly opposite result was obtained, the error becoming 1¾ times greater than that obtained in the second test, where the load is 2⅝ times smaller. The error was adjusted and the scale passed as correct.

The usual correction made in such cases is as follows: An error of 140 lbs. heavy indicates a surplus of weight at the beam rod which lifts the beam above the central balance, and requires the fractional poise to move out to 140 lbs. to counteract the excess. There are means for regulation on all accessible levers below the platform, and when the length of the center lever is known as 96 in. from its stationary point to the slide the correction can be made in this lever, and will correct the whole scale, because the four sections were adjusted to uniform weight in the second test, and required no further readjustment. The true weight of 210,000 lbs. divided by the error 140 gives the correction ratio 1500. Every increment in length of the levers is subjected to this ratio, and therefore the 96 in. difference divided by this number gives the proper movement of the slide, which was in this case .064 in. The lever is made longer if the load is heavy and shorter if the load is light. These alterations in length must only be made at the ends where the slides are provided; corrections on the other side of the fulcrum require an opposite movement.

For illustration, the two pivots in the beam are 4 in. apart, and to correct the error of 140 here would call for shortening the distance $\frac{4}{1500}$ inch.

Coincident with the 5 tests, investigation was made of the time the beam vibrated. Under the light load in the first test the time consumed for vibration of the beam was 16 seconds, and as the load increased more time was required, running up to 23 seconds in the fifth test. There are five series of levers in this scale, and a minute fault or an accumulation of many defects would affect these vibrations materially, and also the sensibility of the beam and platform.

The pivots in a scale are edges formed by two planes meeting at angles of 90 deg. or less, and upon these corners the entire scale revolves, vibrating with a maximum at the end of the weigh beam and a minimum under the rail. By the A. R. A. specification the magnitude of vibration is fixed at 2% of the distance between the fulcrum pivot in the beam and the trig loop (lock or gate). If this distance is 52 in. the vibration will be 1.04 in. vertical movement, and when the total multiplication from beam to rail is 10,800 times, the rail's rise and fall is $\frac{1.04}{10800} = .000096$ in. This is certainly a microscopic movement. The amount of work done in this movement is equal to the load multiplied by the distance moved, or 300,000 lbs. x .000096, which gives 28.8 inch pounds under the rails. At the other end of the scale the motion also gives 28.8 inch pounds of work. No loss from this amount of motion can be tolerated, as will be shown by the following example: Suppose that the lifting has diminished to .000094 in., .000002 of an inch less, the cargo of 300,000 lbs. would be lifted with an imaginarily changed multiplication in lever system of $\frac{1.04}{.000094} = 11{,}060$ instead of 10,800, resulting in the conditions which may be expressed:

$11{,}060 + 300{,}000 = 10{,}800 + X$

$X = 292{,}947$ lbs., making the loss in cargo 7053 lbs.

This error, if it had occurred in the test, would have shown in the fifth one an actual reading of the beam of 205,063 lbs., and a further error before adjusting of 4937 lbs. light. The error was only 140 lbs. heavy in the report, therefore the measurement of 140 lbs. error is beyond the capacity of our existing instruments, and it must be due to some other origin or an accumulation of various minor causes.

The fact that the time of vibration increased with the load shows unmistakably that friction exists. The keen, sharp pivot edges gradually change into minute curves, and herein lays the explanation of the third test, where the error is 40 lbs. light, in relation to the fifth test, which was 140 lbs. heavy. By the manipulation of the roller poise upon the weigh-beam the entire lever system is forced into motion, reacted upon by the 3 test cars, and in the to and fro movement of the poise all joints are rolled into indefinably small and new positions. If the weight is read before the original position has been regained, variable readings can be procured, as seen in the third and fifth tests. In order to support the transmitted weight of the load from the first series of levers under the rail to the weigh-beam, heavy as well as light joints are required, and it is in the heavier joints that the most detrimental friction is generated, causing the sudden fluctuations from light to heavy. In designing a strong structure there is a temptation to make the dimensions of pins, saddles or cylinders excessive without providing sufficient lateral clearance, preventing the free return of members to their previous positions. If figures are used in design such as are suitable for railway bridges, a long lasting structure may be obtained, and yet not a very sensitive weighing apparatus.

Assuming the error of 140 lbs. to exist in a point below the center of the platform where the center lever takes the combined reactions of the inner levers, it will produce here any excess of $\frac{140}{50} = 2.8$ lbs. when the load of 210,000 lbs. on the rails holds all joints in tension. It is only in the free movement of the loops, links, clevises, shackles, steelyard rods, etc., that friction may be caused, and when the 2.8 lbs. friction is overcome by the weigh-beam the verdict will show 140 lbs. heavy. Should the error be somewhere nearer the beam, for instance at the point where the draft rod passes through the floor of the office, the necessary friction need only represent 2-8/10th ounces to be on a par with 140 lbs. on the rail, and 2.8 lbs. under the center of the platform.

It is not fair, of course, to charge the entire error to existing friction, although this may account for the abnormal fluctuation from light to heavy. There are the undeniable results of wear to be considered. A razor which is never honed and stropped will soon fail to cut hair, and the same reasoning applies to any scale, which begins to deteriorate from the day it is set up because of weather conditions, in addition to the work it does.

The test report shows that under this abnormal test the correction would be very easily made by moving the proper parts a certain distance in the designated direction, and this scale has been in service 20 months.

This scale not only weighs the incoming material and fuel for this large plant, but checks the construction of locomotives after the weight upon each wheel is ascertained by scales specially designed for this purpose.

This special scale is really 16 separate scales, and when the total of these 16 scales is read, when a locomotive is placed upon them, the locomotive is then taken to the 150-ton scale and the former weight checked. The weight of the locomotive often exceeds the capacity of the scale by 300,000 lbs., but causes no damage, because the design is based upon low fibre stresses, namely: 1800 lbs. per square inch in the cast iron and all levers when a load of 170 tons is uniformly distributed over the platform. A weight of 80,000 lbs. has been borne upon one of the main levers without leaving a permanent trace or set in the structure. This gives a fibre stress of 42500 : 1800 = 80,000 : x; x = 3388 lbs., which is still low and safe. A 25 lb. weight hung to the end of a beam increases the capacity by 270,000 lbs., and this scale passed such a test, with 240,000 lbs. on the beam in addition. The breaking point for cast iron under such conditions has been found by test to be 35,000 lbs., which indicates that cast iron is preferable to steel, and has a higher modulus of rupture when the proper design and shape of lever is selected.

The test of February 12th, 1915, described herein, was a surprise test, without any preliminary inspection or preparation. The test cars were placed on the platform. The weight of the levers is as follows:

Main levers	580 lbs.
Outer levers	1200 lbs.
Inner levers	1830 lbs.
Center lever	628 lbs.
Rail stands	150 lbs.

The total shipping weight, including bolts, clips and rail stands, was 34,750 lbs.

The following quantities of material were handled in construction:

Excavation	245 cu. yards
Concrete	96 cu. yards
Lumber	1800 ft. B. M.
Structural Steel	32,823 lbs.

The length of the pit, inside measurements, is as follows:

Length	54 ft. 4 in.
Width	8 ft. 8 in.
Depth	8 ft.

The area of the bearing for the main lever stand upon the concrete piers is 500 sq. in. and the area of the bearing for the inner and outer lever is 550 sq. in.

Report of Graduated Test of "Standard" Track Scales—Before and After Adjustment

Date, February 12, 1915.
Capacity, 300,000.
Length, 50 feet.
Location of scale, Baldwin Locomotive Co., Eddystone, Philadelphia.
S. R. under empty balance, 40 pounds.

FIRST TEST.

ACTUAL WEIGHT OF TEST CAR, 50,000 POUNDS.

Indicated result by sections—	Pounds.
First section	50,000
Second section	50,000
Third section	50,000
Fourth section	50,000

Average error per section after adjustment, O.K.

Note.—Place light test weight car on each section of scale successively, entering the indicated weights in the proper columns.

SECOND TEST.

ACTUAL WEIGHT OF TEST CAR, 80,000 POUNDS.

Indicated result by sections—	Pounds.
First section	80,140
Second section	80,040
Third section	80,000
Fourth section	80,140

Average error per section before adjustment, 80 H.

ACTUAL WEIGHT OF TEST CAR, 80,000 POUNDS.

Indicated result by sections—	Pounds.
First section	79,980
Second section	80,000
Third section	80,000
Fourth section	79,980

Average error per section after adjustment 10 L.

Note.—Place heavy test weight car on each section of scale successively, entering the indicated weights in the proper columns.

THIRD TEST.

ACTUAL WEIGHT OF TEST CARS, A. 50,000, B. 80,000 POUNDS.

Indicated result of test—	Pounds.
Actual reading of beam	129,960

Error light or heavy after adjustment, 40 L.

ACTUAL WEIGHT OF TEST CARS, A. 80,000, B. 50,000 POUNDS.

Indicated result of test—	Pounds.
Actual reading of beam	129,980

Error light or heavy after adjustment, 20 L.

Note.—Place one test weight car on each end of scale between end and middle sections, entering the indicated weight in the proper column, reverse light and heavy cars if possible and repeat the test.

FOURTH TEST.

ACTUAL WEIGHT OF TEST CARS, A. 50,000, B. 80,000 POUNDS.

Indicated results of test—	Pounds.
First and second sections	130,000
Second and third sections	130,000
Third and fourth sections	129,980

Average error light or heavy after adjustment, 6⅔ L.

Note.—Place two test weight cars on each end and center of scale successively, entering the indicated weight in the proper columns. Reverse light and heavy cars if possible and repeat the test.

FIFTH TEST.

ACTUAL WEIGHT OF TEST CARS, A. 80,000, B. 50,000, C. 80,000 POUNDS.

Indicated result of test—	Pounds.
Actual reading of beam	210,140

Error light or heavy before adjustment, 140 H.

ACTUAL WEIGHT OF TEST CARS, A. 80,000, B. 50,000, C. 80,000 POUNDS.

Indicated result of test—	Pounds.
Actual reading of beam	210,000

Error light or heavy after adjustment, O.K.

Note.—Place three test weight cars centrally located on scale, entering the indicated weight in the proper column.

Note.—Error (if any) in balance after test: None.

EXHIBIT FOR ROADMASTERS' CONVENTION

Notwithstanding the fact that the railroads of our country for the past three or four years have suffered terrifically at the hands of the public service commissions and the different legislatures throughout the country, and although at the present time they have some fear of what will be done in the future by the enemies of successful corporations, I am convinced that through the energies which railroad officials are inculcating in the management of their properties and the retrenchments they have made, the dawn of better days is at hand.

These facts one can readily comprehend from the encouraging reports which the members of the Track Supply Association are receiving, both from the executive officers of the Roadmasters & Maintenance of Way Association and hundreds of roadmasters throughout the country, who have written letters, saying that they will surely be in attendance at the thirty-third annual convention of their association. The increased orders which are being received for maintenance of way supplies is another evidence of the dawning of better days. It is with a confidence born from these facts that we predict that the fourth annual exhibition of the Track Supply Association, which will be held at the Auditorium Hotel, Chicago, Ill., September 7th to 10th, will far surpass any previous one.

The number of supply firms which have already consented to become members and exhibitors next September is considerably more than we had this time last year, which evidences that a deeper interest is being taken, that confidence is being restored, and we profoundly wish and fervently hope that the railroads will be allowed to work out their own salvation, because we take it that a railroad man knows more about railroading than one does who is occupied in making speeches from the platform to the galleries.

W. C. KIDD, Secretary and Treasurer.

VAN BUREN BRIDGE

The construction of the Van Buren bridge and its approaches on the Canadian side have been approved by the Board of Railway Commissioners for Canada and by the Public Utilities Commissioners of the State of Maine. The property has also been inspected by a representative of the United States War Department, and now it is being turned over by the Van Buren Bridge Company to the Bangor & Aroostook by virtue of an operating contract which has been executed between them. This bridge will be operated by the railroad as agent for the Van Buren Bridge Company, and under that contract the jurisdiction of all officers of the Bangor & Aroostook has been extended over the property of the Van Buren Bridge Company in their respective departments.

Performance of 13 Track Scales

A Study of Consecutive Annual Reports, and Loss in Revenue from Incorrect Weighing

BY A. M. VAN AUKEN

In a circular to the Member Lines, Mr. A. S. Dodge, chairman of the Western Weighing Association, called attention to a fact well known to traffic men, but not well understood by many of those having charge of scale installation and maintenance, in the following words: "Correct weighing assures you proper revenue, which you keep. Poor weighing assures you a loss, for you cannot keep the overcharges, and you never hear of the undercharges."

While railroads in increasing numbers are recognizing this fact and taking measures to better the standard of their scales, as well as their weighing conditions, it appears that all roads are not doing this on a plane or in a manner to realize the full benefit of their increased expenditures. From a close association with a wide circle of railway engineers and scalemen, I can say that where unsatisfactory conditions exist, these men are fully aware of the facts and are not satisfied with the progress being made in betterment. Many of the higher engineers, and but a very few of the non-technical men, realize fully the losses resulting from half-hearted betterment.

There are several explanations for this,—many of the scale salesmen are not technical men and do not always get all of the facts into their argument. The salesman is sometimes afraid his competitor will not be honest. The average engineer is an overworked man and the track scale appeals to him less strongly than a bridge, so he is usually not well read up on the scale question and cannot marshal his arguments for a high class weighing machine as he can for a substantial structure like a bridge.

The purchasing agent does not take kindly to any considerable increase in the cost of purchased articles, and the non-technical man is apt to be wedded to some maker and lean to advice from some certain salesman. One engineer told me that their trouble was not with the scales but in getting the work done correctly; he failed to see that if two scales checked against each other both might be wrong. Another, a non-technical man, who had charge of track scales on a large system, told me that the betterment of conditions on their line was not worth what it would cost, citing the statement of a salesman to the effect that their present scale cost about $1,000, while one to comply with the A. R. A. specifications would cost about three times that amount. In passing it may be well to say that this statement is wrong. An A. R. A. specification scale some 55 ft. over scale irons and designed for a 50 ft. scale rail with a main lever of a capacity of 75,000 lbs. under which load it is not to deflect over the minimum, and with a main pivot of 15 in. long will cost about $1,750. This is about $600 more than the road mentioned is now paying for its scale. As to whether the track scale of a better design would save what it would cost, we simply show the reverse of these arguments to be true in this article.

The writer has recently had a chance to study the condition of about one-seventh of the track scales on the road last mentioned, from a report covering 8 years. There were 13 installations which were tested 146 times. They were correct in 68 instances, were weighing too light in 76 instances and were found weighing too heavy twice. The following conclusions have been deduced, having assumed that at each inspection the scale was put in proper condition for accurate weighing and that when the succeeding test found it in error, it was assumed that the error had increased gradually since the previous test. The loss in dollars was obtained by taking the average charge from the station for the shipments of carload freight for a 30-day period. No claim is made for a gain where the scales weighed too heavily and such temporary causes as the working parts being frozen up were ignored and it was assumed that no weights were taken under such abnormal conditions. The letters in the following text matter refer to the reports of scales at various locations.

DETAILED REPORTS OF SCALE PERFORMANCE

A—The scale mentioned in this report in 1907 was a 36-ft., 4-section, 60-ton scale. In 1910 it was replaced with a 100-ton, 40-ft., 4-section scale with steel weigh bridge. It has weighed an average of 4 cars per day. In the first three years it lost $17,604.00 through underweighing, or $5,868.00 per year, which is 6% interest on $97,800. Since the later scale was installed the estimated loss has been $450.00, or $112.50 per year—almost negligible. The new scale was installed in a concrete pit with a dead rail.

B—The scale mentioned in this report was in 1907 a 36-ft. 60-ton scale, replaced in 1910 with a 100-ton, 4-section, 40-ft. scale with a steel weigh bridge in a concrete pit. Some timber was used in this design. The loss on the old scale was almost negligible, and the new scale has shown correctly at every test for the 5 seasons. The main reason for this good report is that, due to yard changes, the scale has been taken up three times and has been thoroughly cleaned each time. It weighs more cars than the scale mentioned in A.

C—The scale mentioned in C was taken out last year and was a 36-ft. scale of 60-ton capacity, but it was arbitrarily called a 100-ton scale and installed in a very indifferent manner. It weighed about three cars per day and the loss of revenue was about $3,056.10, or $382.02 per year, which would be 6% interest on $6,367.00, indicating that the new scale will be a good investment.

D—The scale mentioned in this report was a 36-ft. 60-ton scale which was replaced in 1910 with a 42-ft. 100-ton scale with steel weigh bridge in a concrete pit. The old scale weighed about 40 cars per day and lost the company about $5,868.00, or at the rate of $1,956.00 per year, which is 6% interest on $32,600.00. The new scale has weighed about 50 cars per day and appears to have lost the company about $9,537.00 or at the rate of $1,907.40 per annum, which is 6% interest on $31,790.00.

E—The scale mentioned in E was a 36-ft. 80-ton scale

from 1907 to 1910. It showed an apparent loss for the company of $11,368.25 or at the rate of $3,789.42 per year, it weighing an average of 60 cars per day. In 1910 this scale was replaced by a 42-ft. 150-ton scale with steel weigh bridge and a concrete pit, the weigh bridge consisting of 24-inch I-beams. This scale has been weighing about 75 cars per day and shows an apparent loss to the company of $16,137.00 or at the rate of $4,034.00 per year, which is 6% interest on $67,237.00. This it will be noted is one of the company's standard "150-ton" scales which the officials thought "good enough."

F—For the first two years, as covered in the reports, the scale at F was a 36-ft. 60-ton scale, and for the past six years it has been a 4-section, 40-ft., 100-ton scale with steel weigh bridge and a concrete pit. The old scale weighed about 40 cars per day and apparently lost the company $4,301.00 or at the rate of $2,150.00 per annum, which is 6% on $35,842.00. The newer scale has weighed an average of 50 cars per day and lost about $6,736.20, or at the rate of $1,122.70 per year, which is 6% interest on $18,712.00.

G—This scale mentioned in G has been condemned, and no reliable description was obtainable.

H—The scale mentioned in H is a 100-ton scale installed with considerable timber in the pit, although it has a steel weigh bridge. It weighs three cars per day. It appears to have lost the company about $6,316.25, or at the rate of $789.53 per year, which is 6% on $13,159.00.

I—The scale mentioned in I is installed in a concrete pit, but has a timber foundation, is 38 ft. long and rated at 100-ton capacity, with a steel weigh bridge. It has apparently lost the company $1,010.60, or at the rate of $126.33 per year, which is 6% on $2,105.50.

K—The scale mentioned in K is another 38-ft. 100-ton scale partly on wooden foundations. This, since the close of the record covered, has been replaced with a heavier scale in a concrete pit. The old scale weighed about six cars per day, and apparently lost the company $4,560.00, or at the rate of $570.00 per year, which is 6% on $9,500.00.

L—The scale mentioned as L was for the first three years a 60-ton, 36-ft. scale which weighed about 10 cars per day. It apparently lost the company $6,336.00, or at the rate of $2,112.00 per year, which is 6% on $35,200.00. The newer scale was a 40-ft., 100-ton scale with steel weigh bridge and concrete pit, and it weighs about 15 cars per day. It has apparently lost the company $148.00, which is at the rate of $29.60 per year, which is interest on less than $500.00 at 6%.

M—The scale mentioned as M may be called a freak. It was an old type 100-ton scale with a 38-ft. wooden weigh bridge, and was installed in a timber pit. For seven years this scale showed correct at every test and then was overhauled and given a rating test, but its day was over; it was worn out and had to be abandoned.

N—The scale mentioned in N is a 100-ton, 40-ft. scale with steel weigh bridge, installed in a concrete pit. It weighs about 12 cars per day. During the last year and a half it was overhauled and has been doing good work, showing correct at the last three tests. Previously to that it apparently lost the company $3,657.60, or at the rate of $562.70 per year, which is 6% interest on $9,378.00.

Just as a contrast to this, the record of another road very similarly situated will be given in brief. The road has 98 track scales, all but 25 having steel weigh bridges and all but three having concrete foundations. Of these 87 are rated at 100-ton capacity. Under a 100,000 lb. test car these tested an average of 26 lbs. light. The tests covering the past year showed that out of the gross number of 304 tests the scales tested o. k. 201 times, too light 98 times and too heavy five times.

The last named company has no scales rated at 150-ton and the losses were mainly on a few scales which were too light for the service. If the first named company had kept its scales in as good shape as the latter the losses on these 13 scales would have been but $1,913.44 per annum instead of $9,636.78. In other words, the loss could have been reduced $7,713.44 by keeping the scales in good repair. And had adequate scales been installed at D, E and F most of the balance would have been eliminated.

Road 2 had 10 scales which were too light for the service, and were responsible for all the bad records on that line. If we assume that road No. 1 had 14 on its road and that these, if heavier and properly cared for, would have turned the record into a good one, we can say that this outlay is needed. In addition an adequate inspection and repair service should be provided.

EFFECTING A MATERIAL SAVING

To install one good sized, well equipped scale shop and one small one at a distant point on the line will cost about $35,000.00, and three additional test cars will add some to this. A superintendent of weighing with a needed clerical force, three additional inspectors to travel with the cars, and four men for the main and one for the branch shop, together with the traveling expenses of men on the road and incidentals, will amount to about $1,600.00 per month. Interest on the cost of shop and test cars and a sinking fund to replace cars and machinery will amount to about $3,250.00 per annum, making the total cost of shops and supervision $22,450.00 per annum. Assuming that the heavier scale will cost $600.00 more than the 150-ton, 42-ft. scale, that it will cost $500.00 more to install it, and that the scale must be renewed every ten years, the interest at 6% will be $66.00 per year, while a sinking fund to replace the extra cost of the scale in ten years will call for $51.00 per year. Taking 14 scales, this will amount to $1,638.00 to be added to the cost of supervision, which will give a total yearly cost of $24,088.00.

On the other hand, if we assume the scales will then average as well as did those of road No. 2, with the 10 bad ones omitted, these 10 failing by being too light for their work, we will have 91 scales on the system, losing the company $13,650.00, as against present indicated loss of $67,457.46 on the entire system, or an annual saving of $53,807.46 from an annual expenditure of $24,088.00. This alone would make the scale department and better scales return a good balance, and it is but a beginning. The company now pays out a considerable sum to scale companies for repairing track scales and another sum for repairing stock and wagon scales, portable and warehouse scales in depots, etc., which could be done at the scale shops. Also the inspection and careful testing of

the 132 track scales owned by industries along the line would result in a large saving through keeping them in better condition. The depot and wagon scales would also be kept in better shape and increase the income.

INDEFINITE DESCRIPTION

But just as long as the railroad companies buy scales by an indefinite description, as "150-ton, 42-ft., 4-section scale," it is probable the makers will fear to submit a bid on a properly designed scale lest the other fellow get the order. Suppose one bidder figures on a scale with main levers calculated for a load of 75,000 lbs. with no undue deflection, with a 15-in. knife edge for the main pivot, while the other figures on a distributed load of 150 tons, giving 50,000 lbs. to each main lever, and only uses a 9-in. knife edge—which will probably submit the cheaper bid? Yet each man can say he is giving a scale of the capacity asked for. Scales have been sold as 150-ton scales which had lighter levers and shorter knife edges than this.

CONCLUSIONS

It is plain that company No. 1 is not securing the results it should from the additional expenditure for heavier scales and better installation. This road's methods seem surprising to one who has studied scales. A long, deep scale pit of concrete has been installed and a deck built with steel girders to carry the dead rail. This deck is designed for the heaviest engine in switching service. The weigh bridge is designed for its load also. These minor parts are designed with all this care, and then a weighing machine is installed of which the company has no accurate knowledge and the engineering department has no stress diagram of the lever or drawings of the pivot. A deflection of weigh bridge is a lesser source of error than one in the scale lever.

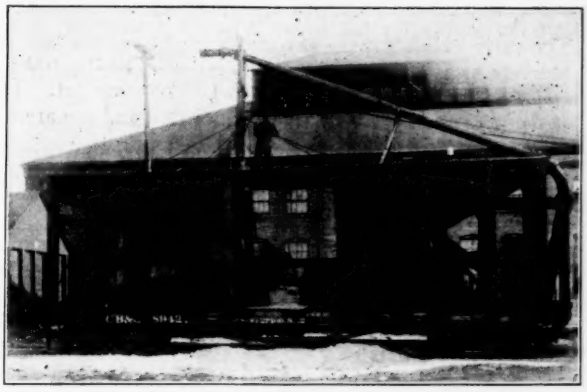
A study of these results will, it is hoped, assist the engineers striving for betterment of scale conditions on their roads. It has been impossible so far to ascertain even comparatively the losses resulting from incorrect depot and warehouse scales, but this is very large. One inspector placed the loss to his road as high as 10% of the amount weighed. Another inspector found on his road a station where weighing was being done with a scale of one multiplication and using weights designed for a scale of a different multiplication, resulting in an underweighing to the extent of one-third the weight of the shipments. Of course, the amount weighed at the station was small, but such instances have been found in larger stations. The wagon scales of today are wholly inadequate. Motor trucks are now built which give a wheel load almost equal to a freight car, and no wagon scale can correctly weigh it.

COST OF PLACING TUNNEL LINING

The work of lining the Arminto tunnel of the C., B. & Q. Ry. with concrete was completed on February 22, 1915. This work was described in detail on page 488 of the December 1914 issue of *Railway Engineering*. It will be remembered that the concrete was mixed and placed by a specially designed car, illustrated herewith, which consisted of a pneumatic concrete mixer and conveyor mounted upon a 40 ft. flat car, equipped with sloping material bins and a measuring hopper in which all materials were transferred to the mixer. The compressed air for operation was supplied through a 4-in. main from a compressor located just outside the tunnel.

In the previous article no cost data was available, and the opportunity is taken to present some interesting data on the cost of mixing and placing concrete for tunnel lining.

Arminto Tunnel work was started July 1, 1914, and about a month was used up in cleaning out the tunnel and laying track, setting up forms and getting ready to make a start. During the first month of the work only 92 cu. ft. of air per minute was available for the concrete work, which limited the capacity to a ¼ yd. batch every



Car Containing concrete mixer and placer for tunnel lining

7 minutes. Later a compressor was ordered, and in the meantime 6 Westinghouse 9½ in. air pumps were used, which increased the capacity of the mixer to ¼ yd. every 2 minutes. When the new compressor arrived, on October 18, 1914, 335 cu. ft. of free air per minute was available, and this average capacity was continued until completion, on February 22, 1915. Some other delays were occasioned by the loose rock which fell from the roof. In one case nearly a car load of rock caved from the roof on top of the forms.

During the month of January 7,964 batches of concrete were placed in 110.6 hours with a gang of 9 men. The total labor cost at 25c per hour was $248.87; this divided by 1,491 cu. yds. equals 16 2-3c per cu. yd. for mixing and placing the concrete, which indeed is a very creditable showing for mixing and placing concrete in such difficult work as tunnel lining.

The pneumatic mixing and placing plant was designed by the Concrete Mixing & Placing Co., Chicago, Ill.

GRADE CROSSING PROTECTION

J. A. McCrea, general manager of the Long Island Railroad, in that company's campaign to put an end to automobile accidents at grade crossings, is urging upon the state of New York action similar to that taken by New Hampshire. That state has just passed a law requiring every city and town to maintain a warning on each side of every highway crossing, to consist of 12x24 in. enameled metal signs with white letters on a blue ground, to be placed at varying distances. If any town neglects to comply with the commission's order for 60 days it forfeits $1 for each day. Any one injuring or defacing these signs is liable to a fine of $10.

Treatment of Concrete Surfaces

Methods of Surface Finish Employed on Structures During Development of the Concrete Industry

BY ALBERT M. WOLF, C. E.

A few years ago little or no attention was given to the surface finish of concrete structures, but to-day the situation has changed entirely, artistic considerations and surface treatment in many cases being given equal weight with structural considerations. This condition has no doubt been brought about by the natural development which follows the extensive use of any building material. The early builders were not aware of the possibilities of concrete as far as esthetic considerations were concerned and the structures were naturally of a wholly utilitarian character. After a few structures had been erected of the new material, men began to evolve various schemes to do away with the unsightly form marks, stone pockets and irregularities so common to concrete surfaces.

EARLY METHODS OF SURFACE FINISH

One of the first methods of surface finish employed was the plastering or washing of the concrete surface (after the forms were removed) with cement mortar or a thin cement grout applied as a wash with brushes. This treatment, although fairly satisfactory when completed, was in general found to be defective after a year or two. Defects develop on account of the difficulty of making a mortar coating or wash stick to the cement film on the surface of concrete which is mixed wet, and on account of the difference in expansion and contraction of the mortar finish and the concrete base. Once the plaster coat has cracked and become partially separated from the concrete, water finds its way between the facing and the concrete and the plaster or wash is forced off by the expansive force of the water freezing.

The integral mortar facing was the next method tried —placing the mortar facing at the same time as the concrete backing—this being accomplished by the use of facing plates so arranged as to be held a certain distance from the forms (¾ to 1 in. or more), the space being filled with the facing mortar and the plates raised as the concreting proceeded. In this way the facing and backing were made practically integral, but due to the difference in the coefficients of expansion of the two materials, difficulties have been experienced in preventing the separation of facing and backing. In general, however, the results have been satisfactory and this method is used quite extensively at present, even though numerous other methods of surface finish have been developed, some of which are cheaper.

MORE RECENT METHODS OF TREATMENT

Soon after the introduction of mortar facing as a surface finish, it was found that a great variety of surface color and texture could be obtained by using various kinds and colors of coarse aggregates in the facing mixture, and then exposing them by removing the surface film of cement. This has been done in several different ways, the cheapest of which is by scrubbing the surface while green with a wire or stiff fibre brush and water. This method has been used very extensively in Philadelphia, many of the concrete bridges built by the city being treated in this manner. (See *Railway Engineering*, November, 1914, page 450, and January, 1915, page 22.)

To give a still better surface, dilute hydrochloric acid and sulphuric acid washes have been used after scrubbing with brushes and water, the acid thoroughly cleaning the surface and thereby emphasizing the color and texture of the aggregate composing the surface. Bush hammering, crandalling and sand-blasting have also been used to accomplish the same general results, but at a somewhat higher cost. The texture obtained by these different methods varies considerably, and advantage is often taken of this fact where contrast between the finish of certain parts of the structure is desired.

Of late years, bush-hammering and sand-blasting have been employed quite extensively on ordinary concrete surfaces without a mortar facing, with excellent results. Surfaces so finished are much improved by washing with dilute hydrochloric acid, which removes the fine particles loosened by the hammer or blast.

At present a great many concrete surfaces are finished by rubbing with carborundum or cement bricks, both coarse and fine. This treatment can be employed on a surface without a mortar facing (if not too irregular) with good results, the surface obtained being of a fine, smooth texture and of a grayish white color. This method of finish was used on the Independence boulevard bridge, Chicago, and was described in detail in the October, 1912, issue of *Railway Engineering;* also in combination with bush-hammered surfaces with excellent effect on the highway arch over the N. Y., N. H. & H. R. R. at South Park, Fall River, Mass., described on page 308 of the June, 1913, issue of *Railway Engineering.*

Colored tile inlaid in the concrete surface has been used in a number of cases to decorate buildings and bridges and relieve the monotony of the plain surface. This method of treatment is rather expensive and the results of earlier work were not encouraging. On later work, notably the 66th avenue arch at Philadelphia (described in the January, 1915, issue of *Railway Engineering*) the results have been much better and this method of decoration will, no doubt, be used more frequently on higher class structures.

Within the past few years a surface finish obtained by spading the concrete against forms lined with sheet metal, and having horizontal triangular grooves or scoring marks to relieve the surface, has been used on some of the largest railroad bridges built, viz., the Tunkhannock and Martin's Creek viaducts of the D., L. & W. R. R. and the Yardley bridge, P. & R. Ry. (see March, 1913, issue, *Railway Engineering*). For large structures such as these, this method of finish is perhaps the most effective which can be obtained at moderate cost, particularly where a close and critical view cannot be obtained.

COSTS

A special mortar facing 1 in. thick will in general cost from 2c to 4½c per square foot. The cost of brushing green surfaces varies from 1½c to 4c per square foot, depending on whether the surface is plain or elaborate.

Bush-hammering, crandalling and sand-blasting thoroughly hardened surfaces will cost from 1¾c to 3c per square foot. Finishing surfaces by rubbing costs from 1½c to 3c per square foot. The cost of washing hammered, rubbed or brushed surfaces with dilute hydrochloric acid is very low, averaging less than ½c per square foot.

NOTES ON THE PREPARATION OF BRUSHED, RUBBED AND BUSH-HAMMERED SURFACES

The motif of a brushed or scrubbed surface is the exposing of a colored aggregate in such a way as to add variety and life to the surface. The main thing, then, where such a surface is to be used, is the selection of the fine and coarse, or the coloring aggregate, as the case may be. If the large aggregate is to be exposed, no spading along faces need be done while placing the concrete, other than that required to avoid stone pockets, for the less spading and the more interior tamping there is done, the nearer will the coarse aggregate be to the surface and the less the work of exposing it. When the small or fine aggregate is to be exposed, the face of the concrete should be thoroughly spaded to bring the fine particles of cement and aggregate to the surface.

Forms for work to be scrubbed should be true and tight and so designed as to safely allow their removal (in general, at least) 24 hrs. after the concrete is placed, or when the concrete is still green. The form work should be so designed and built as to avoid lips at joints between successive sections, for such defects are exceedingly hard to eradicate.

If the concrete is fairly green, a satisfactory surface can be obtained by scrubbing the surface 3 or 4 times with an ordinary fibre or wire brush. In any case, however, scrubbing should be kept up until the surface is of a uniform texture, water being applied frequently, without force, to remove the loosened particles of cement and aggregate. If the concrete is so green that pebbles are scrubbed out, it should be allowed to harden further, for unless this is done the results are sure to be unsatisfactory and the surface of a non-uniform and patchy character.

After concrete has been hardened to some extent the rubbed finish can be obtained much cheaper than a scrubbed or brush finished. For structures from which the forms cannot be readily removed soon after concreting, the rubbed surface is admirably adapted.

To produce the best results a relatively fine aggregate should be used for the form work or the concrete next to the forms should be very thoroughly spaded in order to push back the coarse aggregate and expose only the fine aggregate and cement, such surface requiring less rubbing than when the coarse aggregate is exposed in parts.

In rubbing a concrete surface the first thing to be done is to chip or file off all ridges, lips and projections and to fill voids or stone pockets (should there be any in the surface) with a mortar of the same mixture as used in the concrete. The surface should then be thoroughly wet and rubbed with a coarse No. 16 carborundum stone, sand stone or concrete block until the surface is covered with lather and all the major irregularities in the surface are removed. The lather should then be washed off and the surface dusted with a 1:2 dry mixture of cement and sand, and rubbed in with the No. 16 carborundum stone. The final rubbing should be continued until all the dry mortar has disappeared and the surface is as smooth as possible to make it. The use of plenty of water while rubbing tends to make the finished surface smoother and of a more uniform texture.

By bush-hammering concrete surfaces with hand or pneumatic tools the color of the aggregate is exposed and the monotony of the plain surface further relieved by the roughened surface. As with a brushed surface, a great variety of colors and textures of surface can be obtained by using different colored aggregates and fine or coarse pointed hammers. The best results can be obtained by using a facing material composed of relatively small aggregate, as the presence of large stones near the surface makes it practically impossible to obtain a uniform surface.

For bush-hammering, the concrete should be from 30 to 90 days' old, depending on the weather conditions, the kind of aggregate used and the quality of work required and whether pneumatic or hand tools are to be used. If a fine texture is required the concrete should be hard and the forms used should be of such a nature as to leave a comparatively smooth surface, free from any pronounced ridges, since these lead to a non-uniformity of surface. Where pneumatic hammers are used the concrete should be older and harder than if hand tools are used. Ordinarily, gravel concrete should not be used where bush-hammering is contemplated, since the pebbles will be knocked out of place by the hammer more readily than they will be chipped.

For hand work a light weight hammer, weighing from 3 to 4 lb. with four points, is quite popular and the results obtained are good. Hammers with as many as 16 points are also used. For ordinary concrete bridge work with pneumatic hammers the cost of finishing will average about 3c per square foot.

The surface film is more impervious to water than the rest of the structure, and there is therefore some objection to scrubbing or bush-hammering. On work where these methods are generally used this objection is, however, not of great importance, since a dense concrete will not allow water to get very far, even if the surface film is broken. The rubbed surface does not destroy the surface film and since the pores are filled up by the rubbing, the surface is made more dense and less susceptible to water.

CONCLUSIONS

Recent practice indicates that the brushed or scrubbed, the rubbed and spaded surfaces are the most popular. No doubt this is due to the fact that almost any desired treatment can thus be obtained at a comparatively low cost. For structures subjected to close view of passers-by, and in locations where beauty of surface is necessary, the use of inlaid tile and bush-hammered or scrubbed surfaces is to be recommended.

For small structures the combination of a rubbed surface with brushed or hammered surfaces, to gain contrast of parts, is very effective, or any of the 3 surfaces uesd separately will give pleasing results.

In any case the selection of the kind of surface finish for a structure should be made only after a careful study of the surroundings and environment, since harmony with them is absolutely necessary in order to produce the desired results.

Some Features of Steel Viaducts

The Principles and Conditions Which Should Be Taken Into Account in Making the Design

By A. W. HOFFMANN, Assoc. M. Am. Soc. C. E.

A structural steel viaduct designed to replace a timber trestle will consist of deck plate girder spans of about 60 ft. alternating with shorter spans supported on steel towers resting on concrete pedestals.

Economy of design for any combination of spans depends entirely on arranging the towers in such a way that the greatest heights of the profiles of the ravine are avoided. This feature is too often neglected by the designer, who is sometimes inclined to disregard the cost of the substructures, pedestals and abutments. Co-operation between the steel designer and the concrete designer should be brought about in all cases, in order to settle upon the most economical layout.

Although it is somewhat unusual to bridge the deepest part of the ravine by a longer span in order to avoid towers of extreme height, such a layout might prove economical in many cases. It will often be found that the reduction in the cost of towers and substructures is considerably greater than the increased cost of one or more spans of greater length. In view of this fact, the weight of steel for a viaduct cannot simply be considered a function of the profile area. The length of the structure and the average height as well as in some cases extreme heights of towers should be taken into account.

Without discussing the various formulas for estimating the weight of steel in viaducts, we are giving in Fig. 1 the average weights of 10 viaducts built in 1909 on the Pacific extension of the Chicago, Milwaukee & St. Paul Ry. The curves in Fig. 1 are based on the following assumptions:

Girder spans of 62 ft. 0 in. alternating with spans of 46 ft. 6 in.

Specifications: American Railway Engineering Association.

Loading: Cooper's E-55.

Floor: Reinforced concrete slabs, ballasted track.

Weight of 46 ft. 6 in. span complete, superstructure only ..... 45,000 lb.

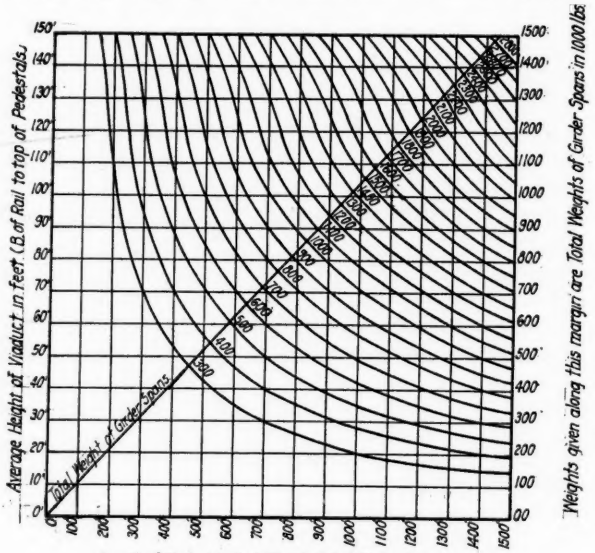
Weight of 62 ft. 0 in. span complete, superstructure only ..... 70,000 lb.

Weight per lin. ft. of columns for transverse bracing ..... 60 lb.

Weight per lin. ft. of columns, for longitudinal bracing ..... 90 lb.

Weight per lin. ft. of columns for bracing details ..... 85 lb.

Weight per cap and base of one column..... 1,700 lb.


Average Height of Viaduct in Feet (B. of Rail to top of Pedestals.)
Total Weight of Girder Spans
Weights given along this margin are Total Weights of Girder Spans in 1000 lbs.
Length of Viaduct in feet (Out to Out of Girder Spans.)

Note:-
Weights given on Curves are Total Weights of Metal in Towers, Bents, Castings, Bolts & Field Rivets in 1000 lbs.

Fig. 1—Curve showing weights of viaducts

Weight per lin. ft. of column shafts of the following sections:

4 angles 4x4x½ in.....	
2 plates 24x⅝ in.....	153 lb.
4 angles 4x4x⅝ in.....	
2 plates 24x⅝ in.....	165 lb.
4 angles 4x4x¾ in.....	
2 plates 24x⅝ in.....	176 lb.
4 angles 4x4x⅝ in.....	
2 plates 24x⅝ in.....	211 lb.
2 plates 15½x$\frac{7}{16}$ in.....	
4 angles 4x4x¾ in.....	
2 plates 24x⅝ in.....	222 lb.
2 plates 15½x$\frac{7}{16}$ in.....	

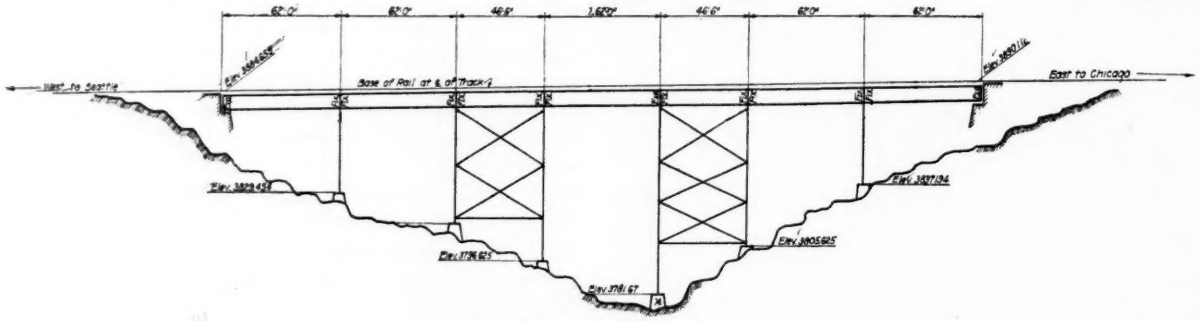


Fig. 2—Typical viaduct layout

Weight per lineal foot of columns, including all bracing (an average found by examining the actual details of 5 viaducts)..... 412 lb.
Weight per lin. ft. of track for concrete slab, ballast and track complete..... 2,600 lb.
Weight of pedestal castings, each..... 1,800 lb.

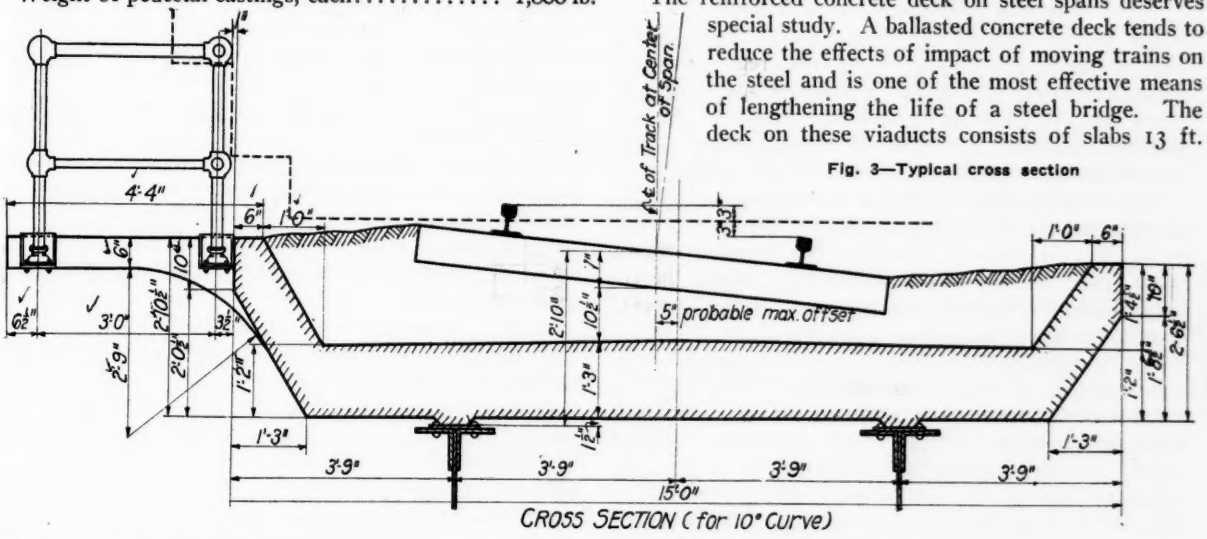


Fig. 3—Typical cross section

Weight of abutment castings, each..... 775 lb.
Two anchor bolts 10 ft. 0 in. x 2½ in. dia. = 370 lb. per Case.
One plate for anchor bolts = 41 lb. per base.

A typical viaduct layout is shown in Fig. 2. It should be noted that the pedestal marked x is built into the lowest point of the profile. It might even have been necessary to build this bent in the water unless construction work was carried on in the dry season. It seems that the faulty location of these pedestals could have been avoided without considerable trouble.

A highly interesting feature of these viaducts was the design of the pedestals for which standards were prepared for rock foundation and for soft foundation, on the basis of a bearing on soil of 9 tons and 5 tons respectively. Heavy pedestals were designed to resist maximum load and transverse thrust only. The top of the pedestal being of a given size, the batters were tabulated as functions of the height for heavy and light pedestals. This method of economical substructure design cannot be too highly recommended.

The abutments of these viaducts were of the reinforced concrete U-type, with a few exceptions where reinforced concrete abutments with open sidewalls and a concrete deck were used (such as were described in the March, 1914, issue of *Railway Engineering*.

The reinforced concrete deck on steel spans deserves special study. A ballasted concrete deck tends to reduce the effects of impact of moving trains on the steel and is one of the most effective means of lengthening the life of a steel bridge. The deck on these viaducts consists of slabs 13 ft. 6 in. wide and about 3 ft. 10 in. long, the slabs setting close together, resting at one end of the span on a lug angle. A space is left between the other end and the lug angle of the next span for expansion. This space is covered by steel cover plates to prevent the ballast from falling through. Refuge platforms are provided on one side, about 150 ft. apart, and a railing is also provided on one side only. The parapet of the slab is given a superelevation when on the outside of a curve. A typical cross section is shown in Fig. 3, and the arrangement at the abutments is shown in Fig. 4.

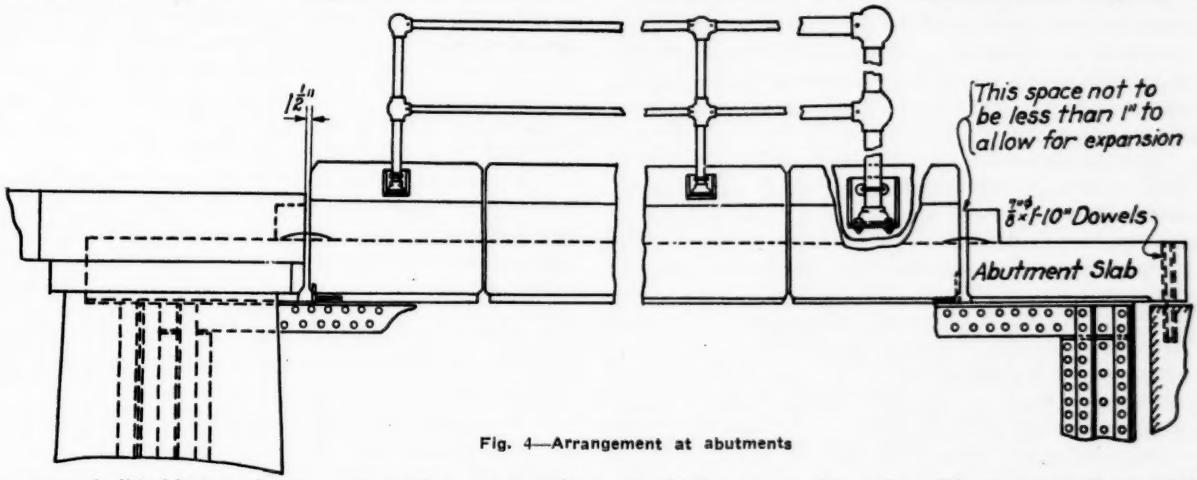


Fig. 4—Arrangement at abutments

The weight of the deck—2,600 lbs. per lin. ft. of track—increases the dead load stresses in the superstructure and the towers considerably. There is, however, no doubt that in the end the ballasted concrete deck is more economical, because the cost of maintenance is not only greatly decreased but greater permanence is also insured.

We are indebted to the C., M. & St. P. Ry. engineering department, Mr. C. F. Loweth, chief engineer, Mr. H. C. Lothholz, engineer of design, for information contained in this article.

The Maintenance Labor Problem

A Continuation of the Discussion of the Methods Used and Opinions on Current Practice

On the Baltimore and Ohio

The greater number of laborers on the Baltimore & Ohio Railroad are obtained from Philadelphia, Baltimore, Pittsburgh, Cleveland, Cincinnati and Chicago. Track laborers are hired through the company's own employment bureau. At times this employment bureau secures the laborers through private labor agencies.

The company does not have an employe at private labor agencies to accept shipments of men for the company. If a large number of shipments of men are being made from one city where the company's employment bureau has no office, the company has a man in that city to attend to the entraining of shipments.

The employment bureau has a chief who reports to the vice-president in charge of operation. Practically all track labor is employed through this bureau. Applications for positions are filed with the bureau, and all service records of men entering the service of the company are kept by it. When the demand for labor is light the divisions are permitted to employ labor locally. When they cannot be procured locally, the men are employed through the employment bureau. When the demand is very heavy the organization is extended to cover a labor agent reporting to the chief of the employment bureau, and as necessity arises district labor agents are stationed at the various large cities from which the labor supply is drawn.

It is not found possible to keep trackmen permanently employed, the track force being reduced to a minimum during the winter months and increased during the working season to that which is considered necessary to carry on the work, the normal ratio of winter to summer force being approximately 4 to 7.

The regular section track laborers usually take care of their own board and lodging. However, in a number of instances it has been necessary to provide lodging for the regular section men. In such cases, if the necessity for so doing is permanent, a two-room house of standard design is built, which provides one room for the bunks, the other for the kitchen and living room. In places where the necessity for these quarters is more or less temporary, a box car is set off the trucks and adapted for living purposes by putting in the necessary doors and windows for light and ventilation. The interior is provided with bunks, space being left for the kitchen and living quarters. In most cases the men rearrange the interior of these cars to suit themselves. In the case of regular section men, they provide their own bedding and cooking utensils.

Extra gangs are usually housed in camp cars, which are left on their trucks so that they can be moved from place to place. Where the gang is large, requiring a number of cars, separate ones are fitted up entirely for bunk cars, usually accommodating 16 men each, and separate kitchen and dining cars are provided. These extra gangs, as well as the regular section gangs, provide their own cooking utensils and bedding. In the winter time the company furnishes stoves and fuel to heat the cars.

In years when labor is quite scarce resort is had to "hobo labor," and contracts are usually made with commissary companies to provide for these men. However, this is only done as a last resort.

The position of leading laborer and of assistant foreman, at a higher rate than paid the balance of the gang, is held out as an inducement for the men to remain with the company and seek advancement. The company is ready to recognize industry and merit in the laborer and promote him to these higher positions, and from these he can be promoted to foreman, supervisor and general supervisor.

There is no regular form of apprenticeship or instruction other than the apprenticeship and practical instruction the men get in the position of leading laborer and assistant foreman. It is the rule to carefully select the men for these positions from promising men in the gang. The supervisor and foreman watch the men very carefully and select the leading laborer and assistant foreman from among the most promising men. In these positions the men are especially instructed by the foremen as to the details of the work. They are trained in methods of handling men by being assigned to supervision of a portion of the gang over some particular details of the work. As the man shows capacity for increased responsibility he is promoted to the position of assistant foreman in an extra gang and drilled in the work of laying rail, ballasting, ditching, etc. It is from these leading laborers and assistant foremen that the section and extra gang foremen are selected. Where it can be done the extra gang foremen are selected from the regular section foremen. The men are gaged for promotion by the ability shown in the handling of the work assigned them and not by the examination test.

This method of selection, instruction, development and promotion of men through the test of practical achievement insures that those with the requisite practical knowledge of the work and known ability as leaders will be chosen. These two qualities in the men holding the supervisory positions, supplemented by a careful study of economic methods of work and their application, raises the standard of the work and increases the efficiency of the working organization.

It is thought that still further improvement in the methods might be accomplished by a more elaborate system of preliminary instruction, somewhat similar to that of shop apprenticeship. However, the rather violent fluctuations in the appropriations for track forces make steady employment uncertain. This robs it of any strong inducement that it can offer to the more enterprising and leads to the belief that any young man who has the ability and persistence to undertake and complete an elaborate apprenticeship course in this class of work would not continue long at it, but would find more attractive employment elsewhere.

On the Canadian Pacific---Lines West

By D. C. COLEMAN, Assistant General Manager

The western lines of the Canadian Pacific Railway, comprising 7,140 miles of single main track and 973

miles of double main track, has the divisional organization. The district superintendent is responsible for all maintenance of way work, and the resident engineer, bridge and building master, roadmaster and signal supervisor on a district report to him.

European laborers are employed mostly for maintenance of way work, these consisting of Galicians, Scandinavians, Italians and Russians. The remaining portion of our maintenance of way laborers are Americans, Canadians, Scotchmen, Irishmen and Englishmen. The laborers are collected in such cities as Montreal, Winnipeg and Vancouver through private labor agencies. No employe of the company is kept at these private labor agencies to accept shipments of men for employment nor is there a company labor bureau. The custom in busy seasons has been to ask the labor agency to supply a certain number of men for extra gang or track section work. These men are transported free to the point of work in charge of a constable, who remains in charge until the men are turned over to the roadmaster under whose direction they are to work. The men's pay begin when they actually commence to work.

The section foreman is provided with a substantially built house of six rooms, generally constructed on a concrete foundation and affording a basement. A rental of $5.00 per month is usually charged, which amount is absorbed in the maintenance expense of the dwelling from time to time. Seventy-five per cent of the section foremen are provided with section houses. The section foreman is also allowed the privilege of using any ground on the right of way in the vicinity of his house for garden purposes. At outlying points the foreman is allowed a market pass to the nearest town and free transportation in baggage cars for the necessities of life. The following transportation privileges also apply to the maintenance of way employees and his direct dependents:

After 6 month's service, pass annually over the district;
After 1 year's service, pass annually over the division;
After 3 year's service, pass annually over the system;
After 5 year's service, pass over foreign lines.

The section foreman is allowed to use old ties for fuel and is provided with a deep well, pipe line connection, or suitable water storage facilities where it is practically impossible to obtain water by drilling or other means. Water for the storage facilities is provided by way freight trains. Permanent employees also have the benefit of the pension rules and regulations as a reward of long years of faithful service. This system calls for no contributions from the employees themselves. The company considered that voluntarily establishing a system under which a continued income will be assured to those who after years of continuous service are by age or infirmity no longer fitted to perform their duties, and without which they might be left entirely without means of support, would tend to build up amongst them a feeling of permanency in their employment and thus create an enlarged interest in the company's welfare and a desire to remain in and devote their best efforts and attention to the company's service. The pension allowance authorized is granted upon the following basis:

For each year of service an allowance of 1 per cent of the average monthly pay received for the 10 years preceding retirement, or preceding the date upon which the company employee attained the age of 65 years, should he be retained in the service after such date. For example, if an employee has been in the service for 40 years and received on an average $60.00 per month for the last 10 years, the pension allowance will be 40 per cent of $60.00 or $24.00 per month. No pension allowance is authorized less than $20.00 per month, however.

If a section foreman wishes to purchase a motor engine, the company stands the expense of installation on a reinforced hand car and supplies the foreman with 10 gallons of gasoline per month with which to operate his car. The foremen furnish their own repairs parts. Power hand cars are not used on mountainous portions of the line. Section men are furnished a bunkhouse, where they provide their own food in many cases. A good many of the section foremen provide table board for the men on their sections.

It is not the custom to retain all of the section force in the winter season as in the summer, but a man who is laid off on account of reduction is given preference when taking on additional men in the spring.

For promotion, it is the practice to have each superintendent furnish a list of men whom he considers would qualify as foremen. The work and habits of these listed men are carefully watched by maintenance of way officers, and promotions are made from among them, due consideration being given to seniority.

The extra gangs are comfortably housed in boarding cars and supplied with wholesome food, usually furnished by a boarding car contractor at a very reasonable rate per week. Such a contractor has his own traveling inspector, who investigates any complaint that may be made. The company's local officers also give this commissary feature close supervision, as it is realized that good food tends to make more satisfactory labor conditions and consequently helps greatly in prosecuting betterment or construction work.

The bridge and building crews have similar privileges to those of section and extra gang men. The commissary end of the boarding cars of these crews is frequently undertaken by the foreman of the crew, each man paying his share of the expenses or else paying a fixed weekly charge to the foreman for his provisions and other services. Pumpmen are provided with cottages near the pump houses at a nominal rental.

All officers concerned with maintenance of way work are impressed with the fundamental truth that in order to derive maximum results at a minimum cost, frequent and intelligent supervision is essential over the constantly changing organization of the members of the section crews, many of whom have but a scant knowledge of the English language.

On the Chicago, Milwaukee & St. Paul

By W. H. PENFIELD, Assistant to Vice-President

Our laborers are obtained in Chicago in general, although sometimes they are procured from Milwaukee, Minneapolis, St. Paul, Kansas City, Omaha, Siox City, Des Moines, Cedar Rapids or various other large cities on our lines.

These laborers are obtained through private labor agencies and are inspected before they are accepted and transportation furnished. No labor bureau is maintained. All matters pertaining to this work are handled through the office of the vice-president of operation and construction.

Track men are not all permanently employed. Forces

are reduced to a minimum during the winter months, the heavy repair work or new construction being done in the spring, summer and fall.

Track laborers are furnished with free bunk cars and every effort is made to have these cars clean and comfortable. During the past two years sanitary bunks or beds have been installed in many cars. Where men desire to board themselves, the necessary cars only are furnished, but where the men desire to have the board furnished them this is arranged for through a firm of private boarding contractors.

No special inducement is offered to track laborers to hold them in the employ other than an effort to always treat them fairly, take reasonably good care of them while on the work, pay them the standard rate of wages in force at the time they are employed, and immediately settle any grievances which they may have against the company or disputes with the officers or foremen under whom they are working.

All section foremen, extra gang and general foremen, and roadmasters are appointed by promotions from other work. An effort is always made to make the promotions from the men most deserving and who give the best results in their particular line of work.

On the Chicago Great Western

By C. G. DELO, Chief Engineer

The maintenance of way laborers for the Chicago Great Western Railroad are obtained in Chicago, Des Moines, Kansas City and St. Paul through private labor agencies. The men furnished are usually inspected before being loaded into the cars at point of shipment. No attempt is made to keep the laborers permanently employed, forces being reduced in the winter or at any other season when work does not demand their employment.

Bunk cars fitted up with common lumber bunks are supplied to movable gangs. Box car bodies are set off trucks at station for section laborers. These are made comfortable with bunks, windows and doors.

No special inducements are offered to hold the laborers, other than the average rate of pay. When a man is discovered to be a good, conscientious track laborer and we deem him competent to handle a section, we usually advance him to assistant foreman and then to section foreman, there being no other method of keeping track of qualifications of track laborers. Before promotion an examination is given each section laborer, but this is merely a verbal questioning by the track supervisor who is making the promition.

As we have no comprehensive organization for handling track laborers, we have been looking to the track supervisors to produce results. Our system being a small one, the general manager, chief engineer and superintendents can all keep in touch with each supervisor and in a large measure with each section foreman. We consider this produces better results than almost any other method.

On the Illinois Central

By W. L. PARK, Vice-President

The greater number of our laborers are obtained from Chicago, St. Louis, Louisville, Memphis and New Orleans, and very often we obtain these through private labor agencies, although foremen generally hire their own men. It is not our practice to have an inspector at the office of the private labor agencies. We find it necessary to reduce the forces during the winter months. Camp cars and portable houses equipped with bunks are furnished the men, but they furnish their own board.

We hold out as an inducement to laborers the promotion of those properly qualified, also the benefits of a hospital system and an educational system at a nominal cost. We do not, however, have a particular system or method for the promotion of laborers. Those who have the qualifications and experience are promoted to assistant foremen and foremen.

Our educational system is not compulsory. Each laborer before being promoted is examined by the supervisor as to his experience and his familiarity with the rules governing maintenance of way employees. He is also required to pass a physical examination. These methods we find have increased safety and secures men of broader experience. We believe that better results can be obtained from this class of labor by providing better education.

On the Chicago & North Western

By W. J. TOWNE, Assistant General Manager

The greater number of our laborers are obtained locally where employment is available. Where men cannot be obtained locally they are shipped from such labor centers as Chicago, Milwaukee, Sioux City, Omaha, etc. At these places the laborers are employed through licensed agencies, it not being our practice to maintain company agencies. A regular inspector is not maintained at the private agencies, but frequent observations are made to see that the men of the proper class are being furnished.

As it is necessary to do most of the work in this northern territory in the spring, summer and fall, we find it necessary to reduce our forces considerable in the winter.

Foreign laborers are provided with comfortable bunk houses to live in. Ordinarily they do their own cooking. Where native extra gangs are employed, boarding outfits are provided for their accommodation and frequent inspection is made to insure an ample supply of wholesome food. Section motor cars are provided to take the men to and from work, and we believe that this is helping to attract men. Newspapers and periodicals are distributed to those working on the line, and all other conveniences are provided which the company is in a position to furnish conveniently.

No particular method is followed in the promotion of track laborers. The selection of men for the position of track foreman is left to the discretion of the roadmasters. An examination is required before a man is employed as foreman.

Although we are trying by closer supervision to get proper results, we are not in a position to say that the standard of work and the reliability of the track maintenance organization has improved to any considerable extent in recent years.

On the Southern Pacific

By W. R. SCOTT, Vice-President and General Manager

Our laborers are obtained from San Francisco, Oakland, Los Angeles, Portland, Sacramento and various other towns. Most of them are hired by direct application of the men themselves to the division engineers, roadmasters or superintendent. The principal exception to this is in the case of Mexican labor used in Southern

California, Arizona and New Mexico, these laborers being hired through a delegated representative established for the purpose. When we do obtain laborers in that way an employee of the company is delegated to the agency to inspect and accept shipment, but we have no labor bureau.

As far as possible it is attempted to keep laborers permanently employed, considering seasonal variations and financial necessities. Section houses and bunk houses are supplied free to track laborers, and large or extra gangs are housed in cars and fed by a boarding contractor at an established rate, such contractor being under the general supervision of the company.

The possibility of proficient men being promoted to section foremen is held out to induce track men to stay with the company. The pension system also is an inducement which keeps men permanently. No particular method is followed in the promotion of laborers and promotion is founded on personal merit.

Fundamentally the efficiency of track labor and its reliability is primarily dependent upon the market for labor. If labor is scarce the efficiency of the track laborer is lowered and the class of men which can be obtained is very commonplace. On the other hand, if labor is plentiful, it is naturally more efficient for obvious reasons, and the employers can more readily pick the better classes and leave the others.

PROGRAM FOR A SEASON'S TRACK WORK

By Maurice Donahoe

Spring—No track should be tamped until the frost is all out from under the ties, with the exception of spots where the track has settled, or frost heaved so much out of cross level or surface that it will not safely carry trains and maintain gage on the frost shims. Smoothing up track, lining track, removing frost shims and tamping ties solidly to the rail should be the first spring work after the frost is out. Gaging and tightening bolts should have been cared for during the winter months, but it should be a fixed rule to gage the track wherever necessary when it is worked in the way of smoothing up, surfacing, renewing ties, etc. The bolts should also be tightened at such times and protruding spikes driven to the rails.

The next thing for foremen on outlying sections to do is to remove all obstructions to waterways—culverts and surface ditches—to care for spring rains and freshets. Foremen in yards and yard sections have, in addition to their routine work, the renewals of crossing plank to look out for in street and highway crossings. On account of the plank having to be taken up often and reset because of being heaved up with the winter's frost, snow and ice, many of them will be ready for renewal.

The next work in order is tie renewals. Much can be said on the manner of handling and placing ties without wasting words. Many track foremen think the only thing there is to do is to dig out the old tie and place in the new tie which is closest, spiking and tamping it to the rail. The ties should be distributed along the track during the winter months at the places where they will be needed for renewal, except in cuts and on high fills. In cuts they would obstruct the waterways and they might roll down the sides of a high bank. They should be heaped up at each end of the cut or fill and this will save approximately one cent per tie in the piling and two cents for carrying them and distributing them for renewals later on. In putting in ties, the ballast bed should not be picked down or lowered any more than is absolutely necessary in order to fit the new tie. In removing the old ties, the track rail should be sprung up one inch, or as much as it can be raised without permitting the ballast to run under the ties. The ballast should be dug out one inch below the bottom of the old tie at one side, the rail sprung up an inch, and the old tie driven into the trench, and then it can be easily pulled out.

The new tie should be chosen to fit the thickness and width of the space where it is to be used, using large or broad end ties under joints and alternating the others, that is, putting a narrow one between two broad ones or a broad one between two narrow ones. Proper spacing of ties should be maintained at all times. On curves requiring superelevation for high speed trains and where low speed drag trains are also frequent, the broad end of the ties should be generally placed under the inner rail of curve, which will probably carry the greatest tonnage. A chalk line should be made on the tie, showing where the outside track should be placed, so that it will not be necessary to measure for line with the spike-maul handle.

If the old ties have not been marked before removal by the supervisor or roadmaster, he should make frequent inspections of the ties removed to know that each and every foreman is using good judgment, and taking careful consideration of the importance of the track, tonnage carried and speed of trains, as well as the condition and distribution of old ties under each rail. Ordinarily on tangent track a poor tie will do service for a year or two if located between two good sound ties. The greater percentage of tie renewals should be completed in the spring except where track is to be surfaced out of a face.

Summer—Track surfacing should be well under way in the summer and should be nearly completed during this season. Track on broken stone or slag ballast should be raised two or more inches each third year to prevent the track from becoming center bound and provide a cushion of additional ballast under the ties. The ballast shoulder should be forked below the bottom of the ties to provide good drainage from the ends and also to prevent weeds from growing. The stone ballast cross section in this way can be maintained with as little ballast as will hold the track to line and prevent the joint ties from skewing. Anti-creepers should also be used on one-way track to prevent the ties skewing, which necessitates ballasting.

On 6-mile sections a sufficient section force should be provided during the working season to enable the foreman to surface two miles of track per year. This would give an entire resurfacing every third year and make unnecessary the practice of trenching and spotting in ties in stone and slag ballast every year, as they could be put in only on the third which is surfaced, omitting nearly all tie renewals on the other two-thirds of the section. Vegetation gets a good start in the late spring and early summer and requires a swath to be mowed on the dirt shoulder and outside the ballast line, and in some cases requires weeding out the ballast.

Mowing the right of way should be done systematically at a certain period. Some roads have to mow their right of way twice during a season. The right of way should be burnt off clean as soon as the weeds are dry to prevent

growth of rank vegetation and damage to adjoining property by fire.

Where the winter weather is too severe to lay rail, this should be done in the spring and summer seasons and it should be surfaced and the ties spaced and anchored before the winter months.

Fall—Some surfacing may be left to complete in the early fall season. The next work in order will be ditching, widening banks, building up dirt shoulder, etc. All surface ditches should be cleaned out, shaped up and deepened as may be necessary, particular attention being given to ditching and draining the ballast in cuts which hold water, and where trouble is experienced from frost heaving the track during the winter months. Good drainage should also be provided for about interlocking plants, switches, railroad crossings, street crossings, water cranes, etc. Ballast should be removed from between the ties to a depth of four or more inches about all switches, spring rail frogs, guard rails and all movable parts of track equipment to have a good working clearance for removal of frost, snow and ice as well as surface drainage.

In busy yards, where surface drainage cannot be well maintained, a system of tile drainage should be provided from all switches to a catch basin. It is also good practice to arrange the work so as to smooth up and line all outlying main track to the best possible condition just before the beginning of winter, so as not to be compelled to do shimming and spike lining early in the winter or after the first frost goes into the ballast.

Winter—Winter track work on outlying sections should consist mostly of renewing bolts, spikes, gaging and repairing and rebuilding right of way fences, and cutting and burning hedge as the weather conditions permit. Shop made shims should be provided where there is much shimming to be done and these should range in thickness from ¼ to ½ in. or more, and they should be spike bored to fit the different rail-base sections. Where high shimming is necessary, say from ¾ to 1½ in., the shim should be about 12 in. long. Shims from ½ to 3 in. thick, which should be the limit, should be 18 in. long with holes bored for boat spikes as well as for rail spikes.

The cinders which accumulate during the winter should be distributed and unloaded on branch lines for ballast, building up shoulder, etc. In yards there will be much work to be done, such as changing rail, adzing ties and turning in rail, applying tie plates and rail braces, renewing frogs and switches, changing angle bars, bolting, spiking, cleaning up at intervals when the ground is clear of snow or thawing, resetting crossing plank, flanging and numerous other jobs.

In localities which have mild winter weather, new rail can be laid more economically in the winter than in the spring, as a better class of labor can be obtained. This also gives an early start in the spring work of surfacing and caring for the new rail and helps to retain the track forces during the winter months. If careful attention is given to proper expansion and shimming over low ties, the rail can be laid and cared for as well in winter as in summer. Wherever rail creeps, rail anchors should be applied when the rail is relaid.

In localities subject to heavy snow a good equipment and organization should be kept at suitable points ready for fighting the snow. In addition to snow plows, flangers, etc., camp and commissary cars should be provided for the laborers. Section foremen and enginemen should keep the despatcher notified of local conditions along the line as to lengths and depths of drifts accumulating, so that the worst places can be given attention first.

After a heavy fall of snow commences to thaw, a trench should be dug through the snow in the ditches, where practicable, to provide an easy outlet for the melting snow water and this should not be left to run at random on and across the track. In yards where the snow fall is heavy, it is often necessary and good practice to load the snow on flat cars and dispose of it at the nearest suitable place. In large terminals the melting of snow and ice around switches and interlocking plants is gradually gaining in favor. Yard forces will find plenty to do in opening up or lowering small trenches to drain water from the switches, even though such trenching has been well done in the fall.

Labor—Retrenchment is the order of the day and most of this is done at the expense of track material and labor. I think it would be advantageous to establish some unit to measure the performance of section gangs, having a system which requires performing certain work at a given period, assuming the track conditions in general to be about the same. If there is more work on one section than on others, then an extra gang should be put on so that the section foreman could keep his track systematically up to the general average.

Maintenance forces should be kept practically uniform during the year. This is, of course, not entirely practical on all roads, but many of the more pronounced fluctuations in the forces can be eliminated.

The best men can be obtained by employing in the early spring and the foremen should always endeavor to secure the most efficient and intelligent men possible. Native labor will generally be found to be the best, if it can be depended upon to remain through the harvest season. Otherwise, the best men among the foreigners should be chosen during this season. The employes who do not measure up to standard should be eliminated from the service, if a better class can be obtained for the wages paid. One or more inefficient and incompetent men in a gang will often influence the entire organization and the detrimental influence may extend to other gangs.

THE SEASON'S WORK

By Supervisor

We do not have the best of material on our line; the gravel in the first place was not of a very good quality and is now worn out. However, we are expected to keep up the ballasting the best we can with the cinders which are received from the cinder pits on our line.

In spring and winter we keep the track shimmed up as carefully as we can, and in the spring we let the track settle well before starting in with the summer work of putting in ties, surfacing, lining and gaging. In summer we do not figure on doing any extensive raising, but do just enough to get the track level and then tamp it up carefully and solid. We use tamping bars for tamping both inside and outside of track. In putting in the ties we do not dig deep holes, but get them in as snug to the rail as possible in order to save working and loosening up the ground.

I also find it a good method in working men, in starting with the complete summer work, to begin at one end of the section and take all of the work out of a face, completing and finishing each day's work by itself, piling up old ties, etc. Where the track becomes rough and it is necessary to do skirmishing or cleaning of the roadbed or any other work that might come up, this of course must be done and the track kept in fair line and surface for the movement of trains. But after such jobs are done the men should continue with their regular work each day, making their report of complete surfacing done and the number of ties put in.

Of course the conditions of rail and ballast and speed of trains have a great deal to do with the keeping up of track. Fast speed and poor conditions of ballast and rail will necessitate more track labor, and under such conditions the allowance of labor should be larger. The ditching is a thing, of course, that is essential if the time can possibly be spared for it in the fall and spring. We use a great many shims in the winter season, many times on 90 per cent of the joints in our main track between November and April.

We use extra gangs in summer season to lay new rail and put in ballast. New ballast stakes are set and the entire operation of relaying and ballasting is done at once. We lay about 1,000 ft. of track, then take the men back and ballast up and complete that amount, dressing up and shouldering the track. We continue this process through the entire stretch of track to be relaid.

ARRANGING THE SEASON'S MAINTENANCE WORK

By W. A. Trimble

The successful supervisor or roadmaster pays strict attention to the arrangement of his work so that it will not be held up or seriously handicapped by causes which may or may not be under his control. It is obvious that the work for each season should be carefully planned so that when the time arrives there will be no delay in the proper and economic execution of the same.

Spring Work—The arrangement of work for spring depends largely upon the kind of winter weather which has preceded. If there has been what is termed an "old fashioned winter," with an abundance of snow, which protects the track structure from becoming frozen to a depth of from 20 to 24 in., the spring work will be greatly reduced. There will be fewer low joints and less improper surface and bad line, due to the track freezing and thawing. With the average winter in Pennsylvania the variation in temperature is not conducive to economy in track maintenance.

With the above conditions to contend with it is necessary for the supervisor to arrange his track forces, including work trains and floating gangs, so that he may promptly take care of policing, cleaning of ditches, scaling of rock cuts, strengthening and rebuilding berm and ditching. It is also imperative that the entire division be given a general overhauling in line and surface. Renewals during this period should be held over as much as possible, as the unsettled condition of the track caused by frost coming out out of the ground makes the need for surfacing imperative.

On a division where standard ditches are maintained, the cleaning of such ditches amounts to a minimum, and for this reason it is often found that the work train may be able to finish the ditching and be assigned to other work. A large percentage of new rail for the year's renewals is received in the months of March, April and May, and the work train should be assigned to distribute rails at this time at the locations designated by the supervisor. It is a great advantage to have the rails distributed then so that they will not interfere with tie renewals during the summer months.

There may be times when with the advent of an early spring the supervisor may be able to get the work in such condition that he can start his tie renewals, but this is the exception rather than the rule.

Summer Work—The summer season should be given up almost entirely to renewals and maintenance—installation of ties and rails, extensive repairs at interlockings, repairs to road and grade crossings, painting of buildings, bridges and track structures, cleaning ditches out to standard, shouldering up track and removing the rock and dirt from cuts. If the line and surface is given the proper kind of attention during the spring but little more will be required during the summer, except what resurfacing is necessary following tie and rail renewals. Particular emphasis should be laid on the fact that summer is primarily for renewal work, and it will be found to advantage to use it exclusively for this purpose.

Fall Work—Much can be done during the fall, or at least the early part of it, along the line of renewals, and where possible renewals should be finished not later than the 30th of October, thereby leaving the entire month of November for a final and general resurfacing, regaging, relining and respiking of the track in preparation for winter. It is also important that all ditches and drain pipes be thoroughly cleaned at this time and the debris removed from around bridge piers. Rip-rap should be placed around abutments to protect them from ice gorges, etc., which are likely to occur during the winter months.

Winter Work—Winter track forces are arranged so as to promptly take care of any trouble caused by snow at interlockings or other places on the division. Particular attention should be given to the prompt removal of snow and ice from tracks adjacent to water troughs. Stretches of track not already tie plated should be given attention during this period of the year. Work trains should spend their time in tie distribution, and the work should be so arranged that absolutely every tie required for the next summer's renewal is delivered to the location where it will be used, so that the spring work will not be delayed by work of this nature. The work train should also be used in removing snow from platforms or other locations where it is dangerous to the traveling public, and where it cannot be removed conveniently by the section forces. Our experience is that it is more economical to load the snow from ditches onto flat cars than to have it carried across two or more tracks and thrown over the bank by the track forces.

Conclusions—We believe that maintenance work can be handled to an advantage as outlined in the foregoing except in the cases of emergency or new construction work. We have found this arrangement to be the best that has been tried and think it can be successfully followed on any system with three or more tracks.

PROGRAM OF WORK

By D. O'Hern, Roadmaster

I have found the followinig outline to be the best that I can devise to fulfil the conditions which I find in our track work.

Spring—The first thing we do in the spring is to get our ties distributed just where we want to put them for renewal. We start this work about March 15th or sooner if possible and add our summer forces about April 1st. Every man is supposed to get his ties in as soon as possible. It is better to put the ties in while the weather is cool, as more can be put in per day than in warm weather.

However, the ties should not be started on in case the track is in need of surfacing, but should be left until the gang is ready to do the surfacing work; for if surfacing is done and ties are put in at different times the cost of the work is greatly increased.

As the renewal of ties causes a loosening up and settling of the ballast, most of them will have to be gone over again and retamped. Then the gangs on each section can be started to surfacing or whatever is to be done in that line, and this work may run into the summer, depending on the condition of the track.

In addition to this, all bolts should be tightened, spikes driven down, and tracks put in perfect gage. Perfect gage is necessary so that the track may be lined up properly. This work, including dressing the work to standard, should be completed by July 1st if possible. During the springtime all old ties should be piled, scrap spikes collected and everything cleaned up as the work progresses.

Summer Work—About the first thing to do in the summer time is to mow the right of way. The old ties should be burned if that is usual procedure, and if not they should be picked up and taken into the yard for engine wood. When the mowing of the right of way and the surfacing is completed the foreman should start over his section looking after the joints. All low spots should be brought up, bolts tightened, spikes driven down and track should be put in good line, with the ballast lined up to standard. The grass should be cleaned away and the track and station ground given a neat appearance. Switch ties should be put in in the summer months, and all switches and railroad crossings put in first class shape. New crossings or switch ties and ballast should be put in so as to have the crossings solid by the next winter.

Fall Work—The first thing to do in the fall is to burn the right of way, as this will prevent expensive fires. The right of way should be burned clear to the fence. If there are any weak sub-grades, banks should be widened and the shoulders built out to protect the ballast. If there is any earth nearby which can be borrowed, especially if cuts can be widened, this should be used to make the shoulders where the fill is not too high, and this work can be done with the section forces. The borrow pit should be kept at least 4 ft. from the bottom of the slope, taking the dirt out parallel with the track, so that the water will have a chance to run away. If holes are dug, they will form water pockets, which naturally weaken the roadbed.

Where the shoulders cannot be widened by throwing up dirt, we use cinders or strippings from gravel pits. The track must have a good shoulder to hold the ballast. Widening embankments should be completed if possible by September. In October the forces should start to clean out all old ditches and make new ditches where required, to give good drainage. All water pipes and small drains under the track and ditches up to the mouth of these pipes should be cleaned out.

Ditches should be opened up clear to the right of way fence and if necessary past the right of way fence into the farmers' fields in order to give the water a free flow. Water is the track's worst enemy, and the further it is kept away from the track the better.

Winter Work—Our winter season starts about December 1st, at which time it is usual to make a reduction of forces. Spikes should all be driven down, bolts tightened and the right of way fences and wing fences put in first-class shape so that this work will not interfere with the spring work.

Snow should be removed from ditches and road crossings. Ditches should be kept cleaned out so that water will have a free flow, and where there is a heavy snow the track should be flanged. During heavy snow storms the snow in cuts should be cleared off and thrown into the ditches, for if allowed to stay on track it weakens it. The track should be kept as bare of snow as possible. Bolts should be tightened twice a year, on account of the change in temperature.

Where we have to change out rails, putting in heavy ones and taking out lighter ones in sidings during the winter, we double up our gangs and do this kind of work, keeping the men busy, thus saving the company quite an amount of money; and in this way we can keep our men on the main track during the summer.

Arranging Spring Work—The work which can be best done in cool weather should be layed out for the spring months. Crowding the work in the spring time gives a number of advantages: First, it places the track forces in good shape for hot weather; second, a better class of men can be obtained; third, the laborers can be kept better than in summer. Farmers and people in other industries commence putting on men during the harvest time, and as they pay more money than railroads it is hard to keep the men on the track.

Arranging Summer Work—If the track is not kept free from vegetation and presenting a neat appearance passengers in observation cars have a chance to criticise our management on the untidy appearance. Therefore the work in the summer should be arranged to keep station grounds, etc., clean at all times, so there will be no chance for criticism on the part of the public.

Arranging Work in the Fall—Spring and summer work should all be brought up to date so that in the fall time may be devoted to widening shoulders and cleaning out ditches, etc., getting ready for winter. All sand cuts should be tiled with sewer tile, and when these are laid the joints should not be plugged up but left open, so that water can have free access. Drain tile should not be used in these cuts, as sand will get into the joints and fill them up, and thus stop the flow of water. The tile should be put in below the freezing point, which is about 3 ft. below the surface. The best of drainage is necessary for first-class track maintenance.

Arranging Winter Work—In the early winter the fences should be put in good shape, the bolts tightened, and the spikes driven down and track gaged if required. I do not advocate that bolts be tightened but twice a year;

they should be tightened whenever loose. On account of the expansion and contraction, however, it is necessary to tighten them at least twice. If snow is removed promptly from track in cuts and thrown into ditches it will have a tendency to help keep the track level, as the drier the track is kept the less it heaves. There are a lot of miscellaneous things that track men have to contend with, which would take too much space to mention further than in the general outline given herein.

MOUNTAIN SLIDES

By D. C. Davis

Only those who are familiar with mountainous localities can fully comprehend the damage caused by slides and falling rocks, from a few stones to many tons. These slides do not all happen during rain storms nor melting snow, for not infrequently there is a fall of stone caused by the wind blowing the dirt from around it, and when it comes down it will frequently loosen a large number of other stones.

During rain and when snow melts there are many places where tons come down at a time, and this cannot be overcome on account of the height of the mountain above the track.

For protection of trains such places require a watchman both day and night, and it is necessary for him to go over the track before and after the passage of every train. These men frequently have to be furnished with dynamite so that when a stone falls down which they cannot roll off they can break it and clear the track. If there is even then more than they can handle they call for additional help or put out flags and carry on as much of the work as they can, and the first train crew which arrives has to assist them in clearing the track.

In 1885 I had some experience with slides where the railway was laid on the side of a hill, necessitating a cut from 3 to 10 feet deep. From the beginning an extra lot of cleaning was necessary on the track ditch in order to keep the upper side properly drained, and the banks gradually encroached on the track so that finally an investigation was made. It developed that the entire hillside, timber and all, was gradually settling down, and if not stopped in some way the road would soon have to be abandoned.

The engineers devised a plan for taking care of this trouble and dug four ditches parallel to the track down to the solid formation. The ditches were 100 ft. apart, and each was about 4 ft. wide. Another series of ditches was dug about 250 ft. apart perpendicular to the track, and these ditches were located where it appeared that the most water concentrated. The slide was checked and has never given any further trouble, but it was an expensive method.

At another point the side cuts were located in clay, which had a bottom on a sloping layer of soap stone. Whenever there was a heavy rain the surface would fall off at the edge and it soon became so bad that it was necessary to keep a watchman continually there, and it frequently required a work train and all the section men to keep the track open. After a heavy slide stopped traffic for 15 hours it was decided best to remove the entire surface of dirt and stone, and a gang was put to work and retained until it was all removed to the top of the hill. This expensive work could have been prevented by cutting a parallel ditch back of the right of way line deep enough to have carried the water away.

Pockets in railway grades are caused by throwing out the mud which comes up between the ties and putting ballast under in its place. Every shovel full of dirt which is thrown out simply increases the water capacity of the basin under the track. There should never be a place left in the road bed under the track that is lower than the outside of the grade. I know of one place where a cut was taken down to within about 3 ft. of soap stone and the track being located on clay never held up well. Orders were given to the section men to throw out the mud and put in cinders. This method was followed until an immense amount of cinders had been put in, and the capacity for water under the track had simply been increased. No permanent relief was effected until drain tile was put in. Had these places been raised and properly drained, the water would never have laid long enough at one place to have produced a soft bottom. I raised a place over 400 ft. long which was hardly passable for trains, using the mud and muck from the ends and shoulders and also from the ditch and putting it under the ties. After raising it about 12 to 18 in. the ditches were cleaned out and good waterway provided, and this entirely eliminated any further trouble.

There are places where the side of an embankment will break off and no reason is apparent. After investigating a large number of such instances I found that the water had started a long ways back of the point where the grades broke off and had formed a sort of a channel running along under the track in the ballast, and finally breaking out of the grade at its lowest point, where the grade changed from descending to ascending. This defect can be remedied by starting back on the grades at the point where the water is likely to collect and putting in cross ditches. The ditches should be made as narrow as men can work in, and cut down just a little below the earth top, but so shaped that any water coming down the center of the track would be caught and carried out each way. These ditches should then be filled with good, clean, coarse gravel. Then other cross ditches put in about 100 ft. apart will soon dry out the fill. In some cases this will not effect as rapid improvement as desired, and a narrow ditch with tiling or some coarse material might be put in about 6 or 8 ft. apart. I have used old boiler flues to tap these water pockets, plugging up the ends and driving them in from the side of the hill at an angle of 30 to 50 degrees until well under the track, and then driving out the wooden plugs with a long rod.

In other places I have used the post hole augur, having a piece of iron rod welded on to make the reach longer and then started at or near the center of the track and bored down into the grade at an angle of about 45 deg. This hole is then filled with gravel and another hole started in toward the side of the grade to meet it and also filled with gravel. This has proven to be a cheap and effective way of draining such pockets.

I have seen a number of fills where ditches were dug entirely across it from 3 to 6 ft., and in some places 8 ft. deep and 4 ft. wide, filling with boulders and making these cuts at intervals of 8 ft. for the full length of the fill. There is no more trouble with water in such places, but there is just as much trouble with the track as before, due to the sides of these ditches caving in and the gravel and dirt washing down in around the bowlders. This

produces a waving surface and it is almost impossible to keep the track in surface.

Tiling must be used in some cases, but it is worse than uesless if it is not placed right. It should not be placed too deep or too far away from the track unless lateral leads are used from the main run up under the center of the ties. If tiling is placed too close to the track, or too shallow, it will be distorted and pushed out of line. There is no rule which can be applied and local conditions and experience are all that can be relied upon in placing tile.

In summing up it can safely be said that there are but few sinking or sliding places in the track which could not have been prevented had the proper work been done by locating the cause and removing it instead of allowing the condition to get very bad before anything was done. If handled in this manner the work can be done at a small outlay; otherwise it may become a gigantic job and prove very expensive.

NEW BOOKS

PRACTICAL TRACK WORK. By Kenneth L. Van Auken, formerly extra gang foreman C. & N. W. Ry.; 216 pages, 51 illustrations, price $1.50 net. Published by Railway Educational Press, Fourteen East Jackson Boulevard, Chicago.

The book Practical Track Work is a distinct departure from anything attempted heretofore in that it treats the subject of track work exclusively and treats it entirely from the viewpoint of the practical man. The simplest possible language is used throughout, the author having omitted engineering terms, technical descriptions or formulas which cannot be used easily by the practical track man.

The author states that the greater part of the information is compiled from his own personal experience and also that the book is not intended as a treatise on maintenance, but merely on track construction. However, it does take up the subjects of switch construction, double tracking and relaying rail, labor and organization, spiking, cutting and curving rails—all of which are likely to come up in maintenance on a progressive railway.

These few instances show that it is just as necessary for the section foreman or roadmaster to know the features of track construction as to know the features of track maintenance. There is no foreman but makes a better man in the maintenance of track if he knows the methods and features in track construction.

The author is well qualified to discuss the subject, as his experience covers seven years in track construction and maintenance, during which time he was engaged on a multitude of different kinds of work, including everything from building grade to putting in double slip switches. In addition he has been for several years gaining information in the positions of editor of *Railway Engineering* and later as editor of the *Signal Engineer* and associate editor of the *Railway Age Gazette*.

Chapter 1 in the book takes up the subject of labor and organization, summarizes method of securing and retaining track laborers, and suggests an organization which inculcates some new ideas and combines the fragmentary successful features of many systems. Chapter 2 takes up the subject of track materials and tools. emphasizes the importance of proper distribution of material and the necessity for good tools and for keeping them in first class condition.

Chapter 3 takes up such general notes as spiking, cutting and curving rails, etc. Several methods of cutting rails are given which are far ahead of the old method of cutting the rail with a chisel all the way around the web and ball. Chapters 4, 5 and 6 take up the subjects of laying track on a new line, building a second track and relaying track—gives original methods for determining correct distribution of material, cites all the different methods used and gives a detailed outline of the organization of the gang, the number of men placed on each kind of work and a description of their duties.

Chapter 7 treats the construction of turnouts, crossovers and ladder tracks. This is one of the most valuable chapters in the entire book and contains 18 diagrams drawn up by the author in the simplest possible manner and which will make it easy for the practical track man to put in any turnout under any condition which will ever be encountered.

Slip switches are treated in Chapter 8 in a manner which simplifies them so that they are most easily understood. A large number of easily read diagrams are also used in this chapter and different methods are suggested for putting in slip switches—among these is that of putting in a slip switch one side at a time—a method which has never before appeared in print. The working knowledge obtainable from this chapter makes it possible for any intelligent man with practical track experience to do this most difficult job of track construction.

Chapter 9 takes up the subject of surfacing new track —emphasizes the necessity for proper design and construction of sub-grade and gives many hints on raising track on a new sub-grade, which is vitally different from raising track in ordinary maintenance. Under Chapter 5, building second track, there are given a number of methods of unloading rails, which are of more than ordinary interest. Among the features which make the book valuable are a detailed summary of the cost of laying track with a track laying machine—an average of two months' work. These data are authentic, having been taken and carefully summarized from the actual reports made out when the work was being conducted. Under Chapter 9 are given a comparison of the cost of surfacing track in the spring and the cost of surfacing track in summer, the supervision being in the hands of the same men in both cases and the only difference being in the grade of labor and rate of pay.

The glossary of track terms (containing about 500 words) is something which appears in no other book and which illustrates the author's familiarity with his subject.

It is certain that any track man who ever expects to have to put in a switch, spur out cars, relay or build new track or do any work of this nature will find this book invaluable, particularly so as the text is so simplified and illustrated by the diagrams as to make it easily understandable by anyone who can read the English language.

B. V. C.

The Chicago & Alton Railroad has recently let contract for new stations at Atlanta, Ill., and at Slater, Mo.

PERSONAL

'Tis only Human Nature with us all
To search the pages till our eyes are lame
That we may learn at once of each success,
Which helped the other fellow win his fame.

'Tis only Human Nature with us all
At sunset when our daily work is done
To ponder o'er the pictures of the men
Who battled with a sea of strife—and won.

We yield to nature's impulse, ere we go,
And read a "live one" at the close of day,
To see promotions in the columns "Personal"
As listed in the "Maintenance of Way."

Take heed, all ye who win your just reward,
A striving brother you may help to climb.
The mileposts in your record of the past
Will help him clear the washouts on the line.

When victory crowns your years of heavy toil,
Send us your record on that very day,
Also your picture for the Column, "Personal,"
As published in the "Maintenance of Way."

Operating

Frederick F. Backus has been appointed assistant to the president of the Toronto, Hamilton & Buffalo Railway, with headquarters at Hamilton, Ontario. This appointment is due to the continuous ill health and resignation of Mr. John W. Eber as general manager. The position of general traffic manager has been abolished.

S. E. Cotter has been appointed general manager in charge of operation and maintenance for the receivers of the Wabash Railroad, with headquarters at St. Louis, effective July 1.

E. T. Whiter has been appointed assistant general manager of the Pennsylvania Lines West of Pittsburgh, with office at Pittsburgh, Pa.

W. C. Downing has been appointed general superintendent of the Northwest system of the Pennsylvania Lines West of Pittsburgh, with office at Pittsburgh, Pa., succeeding Mr. Whiter.

I. W. Geer has been appointed general superintendent of the Central system of the Pennsylvania Lines West of Pittsburgh, with office at Toledo, Ohio, succeeding W. C. Downing.

J. W. Jones has been appointed superintendent of the Western division of the Wabash Railroad, with office at Moberly, Mo., effective July 1.

C. E. Ocheltree has been appointed superintendent terminals of the Wabash Railroad, St. Louis, Mo., succeeding J. W. Jones, promoted. This appointment was effective July 1.

Engineering

W. R. Trowbridge has been appointed pilot engineer of the Pennsylvania Railroad, in the office of the valuation engineer at Philadelphia. He was born September 4, 1879, graduated from the mechanical arts course of the Drexel Institute at Philadelphia in the class of 1898, and entered the Pennsylvania Railroad service on May 2, 1904, as carpenter. He was made rodman on the middle division April 1, 1905, and transitman, at Altoona, Pa., on January 10, 1907. He was promoted to assistant supervisor at Dravosburg, Pa., on October 21, 1907, and was transferred to New Brunswick, N. J., on February 15, 1910. He was promoted to supervisor at Mount Holly, N. J., on July 1, 1913, where he remained until May 1, 1915, the date of his appointment as pilot engineer.

J. G. Hopkins has been appointed pilot engineer in the office of valuation engineer of the Pennsylvania Railroad, with headquarters at Philadelphia. He was born July 29, 1879, educated in the public schools at Williamsport, Pa., and the Williamsport Commercial College, and also completed correspondence school courses. Mr. Hopkins entered the service of the Pennsylvania Railroad on December 7, 1901, as supervisor's clerk at Williamsport, Pa. He was appointed rodman at Williamsport in charge of the drafting room on October 1, 1903, became transitman at Altoona, Pa., September 1, 1905, and was promoted to assistant supervisor at Lock Haven, Pa., on March 7, 1906. He was transferred to Conemaugh, Pa., on April 20, 1909, and was promoted to supervisor at Millersburg, Pa., on May 1, 1912. He remained in this position until May 1, 1915, when he was promoted to pilot engineer, as noted above.

E. F. Vincent, assistant chief engineer of the Colorado & Southern Ry., has been appointed chief engineer, with headquarters at Denver, Colo., succeeding H. W. Cowan, deceased.

Lee Highley, chief engineer of the Pacific & Idaho Northern, having resigned, the office of chief engineer is abolished for the time being.

J. A. Gillies has been appointed acting engineer of the southern district of the Atchison, Topeka & Santa Fe Railway, with headquarters at Amarillo, Texas.

W. R. Devenish has been appointed principal assistant engineer of the Canadian Government Railways, with office at Moncton, N. B.

E. Keough, roadmaster and assistant trainmaster of the Chicago, Burlington & Quincy, has been appointed assistant engineer of maintenance of way of the Canadian Pacific Lines east of Winnipeg, with headquarters at Montreal.

E. N. Layfield has been appointed assistant secretary and editor of publications of the Western Society of Engineers, Chicago. He was previously chief engineer of the Chicago Terminal Transfer Co.

A. H. Nichols has been appointed pilot on the Mobile & Ohio Railroad in connection with federal valuation work.

K. E. Traylor, formerly division engineer at Columbus, Miss., has been appointed field engineer of the Southern Railway, in charge of valuation work.

John Lloyd has been promoted to division superintendent of the Baltimore & Ohio Railroad, with headquarters at Cleveland, O., succeeding A. A. Jackson, who resigned. Mr. Lloyd has been assistant division engineer of the Chicago division at Garrett, Ind. He entered the service of the B. & O. on April 1, 1906.

W. F. McDade, formerly draftsman at the Mobile office, has been appointed acting division engineer of the Southern Railway in Mississippi, with headquarters at Columbus.

W. H. Oliver, division engineer of the Atchison, Topeka & Santa Fe, has been transferred in the same capacity to San Bernardino, Cal.

L. G. Smith has been appointed acting division engineer of the Mobile & Ohio Railroad at Meridian, Miss., succeeding A. H. Nichols, assigned to other duties.

John Dwyer has been appointed superintendent maintenance of way of the Norfolk Southern Railroad, in charge of maintenance of track, bridges and buildings, with headquarters at Norfolk, Va.

Crowell M. Dennis has been appointed transitman in the office of the engineer maintenance of way of the Pennsylvania Railroad.

W. J. Gilbert has been appointed transitman in the office of the engineer of maintenance of way of the Pennsylvania Railroad, with office at Philadelphia.

Zeno N. Kent has been appointed transitman in the office of the engineer maintenance of way of the Pennsylvania Railroad at Philadelphia.

A. M. Harvey has been appointed signal supervisor of the Canadian Government Railways, with office at Moncton, N. B.

Maintenance of Way

J. W. Keenan has been appointed supervisor of the Williamsport division of the Pennsylvania Railroad. He was born April, 1874, at Sunbury, Pa., graduated from Pennsylvania State College in 1898 and entered the employ of the Pennsylvania on March 29, 1900, as rodman. He was made transitman in the office of the principal assistant engineer at Altoona, Pa., on December 7, 1902, and was advanced to supervisor at Southport, Pa., on June 1, 1903. On May 1, 1905, he was transferred to Tyrone, Pa., and was promoted to supervisor at New Bethlehem, Pa., on January 15, 1907. He was transferred to South Fork, Pa., on July 1, 1909, and on November 1, 1912, became supervisor of the Cumberland Valley Railroad. He held this position until May 1, 1915, when he was appointed supervisor of the Williamsport division, with headquarters at Millersburg, Pa.

C. L. P. Russel has been appointed supervisor of the Cresson division of the Pennsylvania Railroad with headquarters at Cresson, Pa. He was born July 31, 1881, finished his education with correspondence school work and was first employed by the Pennsylvania on September 15, 1904, as transitman in the department of the engineer branch lines. January 1, 1906, he was transferred to the construction department and one year later to the maintenance of way department. He became transitman at Altoona, Pa., on April 1, 1909, was advanced to assistant supervisor at Driftwood, Pa., on June 1 of the same year, and June 10, 1912, was transferred to Middletown, Pa. He was promoted to supervisor of the Cresson division, effective May 1, 1915.

R. F. Wunderly has been appointed supervisor of the Allegheny division of the Pennsylvania Railroad. He was born in Nazareth, Pa., August 4, 1882, graduated from Franklin and Marshall College in 1899 and from Lehigh University in 1904. Mr. Wunderly entered the service of the Pennsylvania May 15, 1905, as rodman on the Philadelphia terminal division. He was promoted to transitman in 1908 and to assistant supervisor in 1909. He was later transferred to the Pittsburgh division, where he remained until May 1, 1915, when he was promoted to supervisor of the Allegheny division.

Porter Allen has been appointed supervisor of the Buffalo division of the Pennsylvania Railroad, with headquarters at Olean, N. Y. He was formerly supervisor at Uniontown, Pa.

E. J. Ayars has been appointed supervisor of the Buffalo division of the Pennsylvania Railroad, with headquarters at East Aurora, N. Y. He was formerly supervisor at Norristown, Pa.

Donald C. Baird has been appointed supervisor of the Pittsburgh division of the Pennsylvania Railroad, with headquarters at Uniontown, Pa. He was formerly supervisor at Watsontown, Pa.

William B. Groff, Jr., has been appointed supervisor of the Williamsport division of the Pennsylvania Railroad, with headquarters at Watsontown, Pa. He was formerly supervisor at Cresson, Pa.

Robert B. Harris has been appointed supervisor of the Trenton division of the Pennsylvania Railroad, with headquarters at Mount Holly, N. J. He was formerly supervisor at New Bethlehem, Pa.

S. H. Kuhn has been appointed supervisor of the Schuylkill division of the Pennsylvania Railroad at Norristown, Pa. He was formerly supervisor at Olean, N. Y.

Charles A. Pfalzgraff has been appointed supervisor of the Cumberland Valley R. R., at Chambersburg, Pa. He was born May 31, 1878, and completed his education at the Pottsville High School, from which he graduated in 1895. He was first employed by the Pennsylvania Railroad on May 8, 1900, as rodman in the office of the principal assistant engineer at Williamsport, Pa., and was promoted to transitman at Altoona, Pa., on March 1, 1903. On September 1st of that year he was promoted to assistant supervisor at Osceola Mills, Pa., and on July 1, 1905, was transferred to Huntingdon, Pa. July 1, 1907, Mr. Pfalzgraff was promoted to supervisor at Olean, N. Y., and was transferred to East Aurora, N. Y., on August 1, 1911. His appointment as supervisor of the Cumberland Valley Railroad was effective May 1st.

C. T. Sponsel, who has been appointed roadmaster of the Northern Pacific Railway at Garrison, Mont., was born March 31, 1887. He devoted 3 years to civil en-

gineering at the University of Illinois, and in 1910 entered the service of the Northern Pacific, holding the positions of chainman and rodman. In 1911 he was promoted to resident engineer, after which he was promoted to roadmaster. May 26, 1915, he was transferred to the main line of the Rocky Mountain division, between Helena and Butte.

F. H. Carpenter has been appointed roadmaster of the Western division of the Atchison, Topeka & Santa Fe Railway, at Hutchinson, Kans., succeeding A. West.

C. L. Poland has been appointed roadmaster of the Kansas City, Mexico & Orient Railway of Texas, with headquarters at Benjamin, Texas, succeeding C. A. Finke.

R. L. Pryor has been appointed roadmaster of the Panhandle division of the Atchison, Topeka & Santa Fe Railway at Hutchinson, Kansas, succeeding F. H. Carpenter, transferred.

L. T. Raymond has been appointed roadmaster of the Atchison, Topeka & Santa Fe Railway, Panhandle division, at Belvidere, Kansas, succeeding Samuel McGaughey.

Hans Olson has been appointed assistant roadmaster first district, on the Minnesota division of the Northern Pacific Railway, with headquarters at Staples, Minn.

L. R. Fleming has been appointed assistant supervisor of the Philadelphia division of the Pennsylvania Railroad, with headquarters at Middletown, Pa. He was previously assistant supervisor at Woodbury, N. J.

Boyd M. Frymire has been appointed assistant supervisor of the Renovo division of the Pennsylvania Railroad, with headquarters at Driftwood, Pa. He was previously assistant supervisor of the Cresson division.

Frank S. Gates has been appointed assistant supervisor of the Trenton division of the Pennsylvania Railroad, with headquarters at Jamesburg, N. J. He was previously assistant supervisor on the Renovo division.

R. H. Hellick has been appointed assistant supervisor of the Trenton division of the Pennsylvania Railroad, with headquarters at Mount Holly, N. J. He was previously assistant supervisor at Irvona, Pa.

C. O. Long has been appointed assistant supervisor of the Cresson division, with headquarters at Cresson, Pa. He was previously transitman in the office of the engineer of maintenance of way.

E. W. McGarvey has been appointed assistant supervisor of the Philadelphia division of the Pennsylvania Railroad, with headquarters at Philadelphia. He was previously transitman in the office of the engineer maintenance of way.

J. B. McWilliams has been appointed assistant supervisor of the Trenton division of the Pennsylvania Railroad, with headquarters at Mount Holly, N. J. He was previously assistant supervisor on the Elmira division.

C. W. Newell has been appointed assistant supervisor in the office of the valuation engineer of the Pennsylvania Railroad, at Philadelphia. He was previously transitman in the office of the engineer of maintenance of way.

L. St. Clair Pie has been appointed assistant supervisor of the West Jersey & Seashore Railroad, with headquarters at Woodbury, N. J. He was previously assistant supervisor of the Trenton division of the Pennsylvania Railroad.

J. R. Scarlett has been appointed assistant supervisor of the Philadelphia terminal division of the Pennsylvania Railroad, with headquarters at Philadelphia. He was previously assistant supervisor of the Philadelphia division.

F. L. Shea has been appointed assistant supervisor of the Philadelphia terminal division of the Pennsylvania Railroad, with headquarters at West Philadelphia. He was previously assistant supervisor at the Broad Street and Washington Avenue station.

William W. Shuster has been appointed assistant supervisor of the Baltimore division of the Pennsylvania Railroad at Parkton, Md. He was previously assistant supervisor at Jamesburg, N. J.

R. J. Smith has been appointed assistant supervisor of the Elmira division of the Pennsylvania Railroad, with headquarters at Elmira, N. Y. He was previously transitman in the office of the engineer maintenance of way.

H. E. Tyrrell has been appointed engineer maintenance of way of the Western District of the Southern Railway, with headquarters at St. Louis, Mo., succeeding G. E. Buckley, transferred. This appointment was effective July 1.

G. E. Buckley has been appointed engineer maintenance of way of the Northern District of the Southern Railway, with headquarters at Richmond, Va., succeeding W. T. Dobyns, resigned. This appointment was effective July 1.

NEW STRUCTURES ON THE G. C. & S. F.

The Gulf, Colorado & Santa Fe has recently completed a depot at Goldthwaite. The structure is 28 ft. x 90 ft. 6 in., of mission type architecture, built of brick and stucco. It has a concrete foundation, concrete floor, tile roof, vitrified brick platform 450 ft. long, and is electric lighted, including platform lights. The sheet metal work is copper. No plumbing or heating is provided.

A passenger depot has also been completed at Coleman, Texas, which is 20 ft. 6 in. x 120 ft. long, mission type, of brick and stucco construction. The foundations are concrete, as are also the floors. This depot also has a vitrified brick platform 450 ft. long and a tile roof. The building is to be heated by a hot water system and lighted by electricity, including the platform lights.

It is proposed to remodel the Beaumont, Texas, depot, the present structure being 40 ft. x 72 ft. long. A second story will probably be added for use as a freight office. The building is of red brick with stone trim, and it will have cement floors. Train sheds of the umbrella type, of steel and wood, are proposed, 300 and 450 ft. long respectively. A new sidewalk will be laid on Neches street and new vitrified brick platforms will be laid under the train sheds. The train sheds will be connected with the depot by a covered midway. This building will be provided with plumbing, electric lighting and hot water heating.

USE OF SILICA-GRAPHITE PAINT

A practice that is fast being adopted in progressive power plants is that of using paint for the inner surface of steam boiler drums. The paint is said to afford protection against pitting. Silica-graphite paint is used for this purpose and for a number of years the manufacturers of this paint have coated the steam drums of five B. & W. boilers developing 1,800 H. P. and as a result the drums are in almost perfect condition. In another plant

equipped with B. & W. boilers developing 8,400 H. P., the interiors of the drums were scalded, painted both above and below the water line and allowed 48 hours to dry thoroughly. This treatment was repeated every ten months and not only did it stop pitting but where it had previously taken six men seven days to clean the drums of one boiler, two men now clean them in a day. This latter experience is quoted from a letter of the chief engineer of the New York Life Insurance Company, in the April issue of Graphite.

The Atchison, Topeka & Santa Fe Ry. has awarded contract for the steel for a new elevator at Argentine, Kan., 375 tons, to the American Bridge Co.

The Chesapeake & Ohio, Southern and Norfolk & Western railways co-operating with the city of Lynchburg, Va., will erect a bridge crossing the James river and connecting the city with Amherst county. A reinforced concrete structure 1,700 feet long is proposed, beginning at Seventh and Commerce streets, with an arm extending to Cabell street and inclines into Jefferson and Orange streets. The estimated cost is $300,000. Construction is to begin before January 1, 1916.

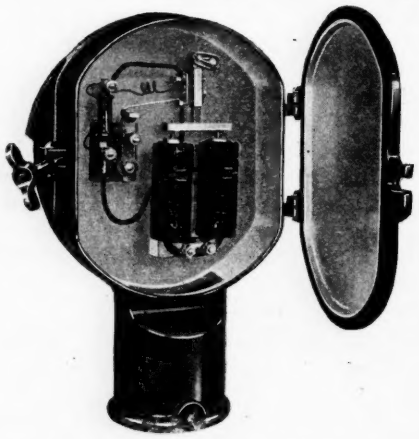
The Chicago & North Western has awarded the contract for the pile foundation of its elevator at Kinnickinnick, Wis., to the Walsh Construction Company, Davenport, Iowa.

The Chicago, Burlington & Quincy has awarded the contract for the steel work of its Kansas City bridge to the American Bridge Company. The contract calls for 5,500 tons of steel.

NEW CROSSING BELL

The Hall Switch & Signal Company, New York City, has developed and put on the market the new crossing bell illustrated herein.

The principal features of this bell are ruggedness, simplicity of design and accessibility; it meets all R. S. A. specifications. It is 17 in. high, 12 in. wide, 6½ in. deep, and weighs only 43 lbs. The coils are form wound, impregnated and absolutely moisture proof. The resistance unit connected in multiple with the magnet coils



New Hall crossing bell, door opened

practically eliminates arcing at contacts, which are furnished of carbon or metal as desired.

The case is so designed that the mechanism may be inspected by opening the door without removing the gong or loosening screws. All parts are easily removed and replaced, which admits of repairs being made quickly. The bell can be mounted on the top of a 4 in. iron post,

Hall crossing bell with door closed

or it may be clamped to the side of an iron pipe or to a wooden post by means of a Universal support.

At normal operating voltage the clapper strikes approximately three times a second, which gives a more effective warning than that given by a gong struck at a more rapid rate. The slower striking gong also has less wear on its moving parts.

NEW LITERATURE

The Chicago Pneumatic Tool Co., with offices in the Fisher Building, Chicago, and 52 Vanderbilt St., New York, has issued bulletin 34-X, dated May, 1915, relating to the class A-G "Giant" gas and gasoline engines. The bulletin illustrates these engines in six sizes, ranging in horsepower from 16 to 130. The engines are similar in general design to the well known Giant fuel oil driven engines manufactured by the same company, with the exception that they are designed for operation with manufactured or natural gas. Their enclosed self-oiling features, extreme simplicity and perfect automatic regulation should recommend them throughout the field where manufactured or natural gas is available for power purposes.

The Kennicott Company, Chicago Heights, Ill., has just completed a very attractive and instructive catalog on filtering water. In fact, it is more than a mere catalog —it is a treatise on modern filtration.

The first few pages are devoted to illustrations of large office buildings equipped with filters, and to an introduction and discussion of the general problem of filtration, and economies and other resulting advantages. Pages 15 to 30 contain descriptions, illustrations, etc., of a large number of different types of filters which are designed to meet any condition that will be encountered. The remaining pages are given over to photographs of installations or of buildings in which installations have been made, with letters from the companies installing them, giving their opinions of the filters. A few pages in the back of the book are devoted to gravity filters and the Kennicott water softener.